MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

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SIR DAVID GILL, K.C.B., F.R.S., PRESIDENT, in the Chair.

Penry Vaughan Bevan, M.A., Professor of Physics, Royal Holloway College, Englefield Green, Surrey;
David Brunt, B.A., Trinity College, Cambridge;
Rev. John Crouch, President of the Paisley Philosophical Institution, Felsberg, Bridge of Weir, Renfrewshire.
Charles Eddie, Examiner of Masters and Mates, Port of Vancouver, British Columbia;
Henry Hart, Mangalore, South Canara, India;
Capt. Alexander Inglis, Harbour Master, Port Adelaide, Glanville, South Australia;
Capt. W. E. Maddocks, Harbour Master, Port Swettenham, Selangor, Federated Malay States;
Capt. Francis Crofton Molesworth, R.E., United Service Club, Simla, India;
Walter Moss, Solar Physics Observatory, South Kensington, and 1 Braemar Avenue, Wimbledon Park;
John William Nicholson, M.A., D.Sc., Trinity College, Cambridge;
James Harry Smith, F.C.S., M.P.S., 5 Turks Road, Radcliffe, Lancashire;
Morris Francis Weinrich, M.E., A.M., Ph.D., Instructor in Physics, Stevens Institute, Hoboken, New Jersey, U.S.A.;
George Joseph Weldrick, 12 Booterstown Avenue, Booterstown, Co. Dublin; and
Rev. Charles Whyte, United Free Church Manse, Towie, Glenkindie, Aberdeenshire,

were balloted for and duly elected Fellows of the Society.

The following candidates were proposed for election as Fellows of the Society, the names of the proposers from personal knowledge being appended :—

Sydney Chapman, Royal Observatory, Greenwich, S.E. (proposed by F. W. Dyson) ; and
Harold N. Haskell, B.A. (Merton College, Oxford), Mathematical Master, Harrison College, Barbados, West Indies (proposed by H. H. Turner).

Sixty-nine presents were announced as having been received since the last meeting, including, amongst others :—

Ole Römers Adversaria, published by the Royal Danish Academy of Sciences, presented by the Academy ; T. J. J. See, Researches on the Evolution of Stellar Systems, vol. ii., the Capture Theory of Cosmical Evolution, presented by the Author ; The Greenwich Observations for 1908, presented by the Royal Observatory, Greenwich.

Astrographic Chart of the Heavens ; 13 charts, presented by the Tacubaya Observatory.

Verification of the Centre Yard and the Three Centre Feet on the Royal Astronomical Society's 5-ft. Tubular Brass Scale. By H. B. Darling, B.Sc.

(*Communicated by Major P. A. MacMahon, F.R.S.*)

This scale was constructed by Troughton & Simms in 1833, and in the following year was compared by Baily with the Imperial Standard Yard of that period. An account of these comparisons and a full description of the scale are given by Baily in an elaborate report published in the *Memoirs of the Royal Astronomical Society* for 1836. The centre yard 0 . . . 3 ft. was then found to be 0·000376 inch longer than the imperial standard with which it was compared, and the relations between the three centre feet and the centre yard were found to be as follows :—

0 . . . 1 ft. = ⅓ centre yard + 0·000125 inch.
1 . . . 2 ft. = ⅓ centre yard − 0·000037 inch.
2 . . . 3 ft. = ⅓ centre yard − 0·000088 inch.

It may be explained that the lines defining the 5 feet on the scale are marked as follows :—

12 . . . . . 0 . . . . . 1 . . . . . 2 . . . . . 3 4,

—so that the centre yard is the length represented by the interval between "0" and "3" on the scale.

The present comparisons were undertaken by the Deputy Warden of the Standards (Major P. A. MacMahon), at the request of the Royal Astronomical Society. The comparing standard was the distance 0 . . . . 36 inches marked on the official bronze bar known as "SS," the length of which has been accurately determined in terms of the present imperial standard yard. Three series of comparisons were made, in each of which the bar SS was supported on eight rollers placed in the positions for minimum flexure. In the first series of comparisons the Royal Astronomical Society's scale (denoted hereafter by "RAS") was supported in the same manner as during the comparisons made by Baily, viz. on two rollers placed at $15\frac{3}{4}$ inches from each end. The second series was made with RAS supported on eight rollers. In each of these two series RAS was on the same side of the comparator. In the third series it was on the other side, and the bar was reversed end for end and supported on eight rollers. The results of these comparisons are given below.

First Series.

Date.	Observed Difference. RAS Centre Yard =SS 0 . . . 36 Inches	Correction to reduce to 62° F.	At 62° F. RAS Centre Yard =SS 0 . . . 36 Inches
1907	Inch.	Inch.	Inch.
May 30	+0·001389	−0·000279	+0·001110
,,	+0·001403	−0·000205	+0·001198
,,	+0·001388	−0·000288	+0·001100
,,	+0·001501	−0·000313	+0·001188
31	+0·001202	−0·000112	+0·001090
,,	+0·001357	−0·000184	+0·001173
,,	+0·001328	−0·000230	+0·001098
,,	+0·001257	−0·000119	+0·001138
,,	+0·001321	−0·000198	+0·001123
,,	+0·001527	−0·000304	+0·001223
Mean	+0·001367	−0·000223	+0·001144

Second Series.

June 1	+0·001188	−0·000052	+0·001136
,,	+0·001263	−0·000115	+0·001148
3	+0·001406	−0·000188	+0·001218
,,	+0·001400	−0·000207	+0·001193
,,	+0·001229	−0·000055	+0·001174
,,	+0·001348	−0·000104	+0·001244
Mean	+0·001306	−0·000120	+0·001186

Third Series.

Date.	Observed Difference. RAS Centre Yard =SS o . . . 36 Inches	Correction to reduce to 62° F.	At 62° F. RAS Centre Yard =SS o . . . 36 Inches
1907	Inch.	Inch.	Inch
June 4	+0·001103	−0·000020	+0·001083
,,	+0·001099	−0·000081	+0·001018
5	+0·001337	−0·000073	+0·001264
,,	+0·001296	−0·000049	+0·001247
,,	+0·001352	−0·000005	+0·001347
,,	+0·001228	−0·000058	+0·001170
6	+0·001307	−0·000050	+0·001257
,,	+0·001341	−0·000027	+0·001314
,,	+0·001533	−0·000062	+0·001471
,,	+0·001275	−0·000028	+0·001247
,,	+0·001335	−0·000042	+0·001293
,,	+0·001444	−0·000031	+0·001413
Mean	+0·001304	−0·000044	+0·001260
General mean of the three series	+0·001327	−0·000124	+0·001203

As nothing was known respecting the present errors of the thermometers attached to the RAS scale, and as their readings differed considerably among themselves, the temperatures during the comparisons were ascertained by means of two Tonnelot thermometers which had been recently verified, one of which was fastened to either bar.

Since the length o . . . 36 inches on the bronze bar SS at 62° F. is known to be

SS o . . . 36 in. = 35·999847 inches.
= imperial standard yard − 0·000153 in.

it follows from the general mean above that RAS centre yard at 62° F. = imperial standard yard + 0·001050 inch.

According to Baily, the expansion of the RAS centre yard for 1° F. was 0·000377 inch, which corresponds to 0·0006786 inch for 1° C., and this value was followed in the above reductions. The expansion of the yard SS for 1° C. is 0·0006389 inch.

The length of the comparing standard used by Baily is not known in terms of the present imperial standard yard, and it cannot now be ascertained, as the standard in question was practically destroyed in the fire at the Houses of Parliament in 1834, a few months after Baily had completed his comparisons.

It would appear from page 679 of Airy's account of the Construction of the New National Standard of Length (*Phil. Trans.*,

1858) that, from comparisons made during 1851–5, the RAS centre yard was then found to be 0·000420 inch longer than the present imperial standard yard, so that during the last fifty years the RAS yard would appear to have increased in length relatively to the imperial yard by 0·000630 inch. Airy assumed the expansion of 1 yard of the RAS scale for 1° F. to be 0·000344 inch, which corresponds to 0·0006192 inch for 1° C. If this value were adopted in the present comparisons, the results given above would be reduced by 0·000016 inch, so that we should obtain

RAS centre yard at 62° F. = imperial standard yard + 0·001034 in.

The corresponding change in length since the 1851–5 comparisons is seen to be still very considerable. Airy appears to have regarded this yard as unreliable; and although his strictures were somewhat modified later, it would now appear that his earlier unfavourable judgment was correct, inasmuch as the absolute length of this yard at 62° F. has not remained invariable.

The results of the comparisons of the 3 feet forming the centre yard of the RAS scale are as follows:—

Comparison of RAS 0 . . . 1 *Ft. with SS* 0 . . . 12 *Inches.*

Date.	Observed Difference. RAS 0 . . . 1 Ft. = SS 0 . . . 12 Inches	Correction to reduce to 62° F.	At 62° F. RAS 0 . . . 1 Ft. = SS 0 . . . 12 Inches
1907	Inch.	Inch.	Inch.
July 1	+0·000509	−0·000054	+0·000455
5	+0·000502	−0·000044	+0·000458
,,	+0·000532	−0·000077	+0·000455
,,	+0·000550	−0·000038	+0·000512
,,	+0·000512	−0·000078	+0·000434
Mean	+0·000521	−0·000058	+0·000463

Comparison of RAS 0 . . . 1 *Ft. with SS* 12 . . . 24 *Inches.*

Date.	Observed Difference. RAS 0 . . . 1 Ft. = SS 12 . . . 24 Inches	Correction to reduce to 62° F.	At 62° F. RAS 0 . . . 1 Ft. = SS 12 . . . 24 Inches
1907	Inch.	Inch.	Inch.
July 8	+0·000516	−0·000049	+0·000467
,,	+0·000614	−0·000085	+0·000529
,,	+0·000532	−0·000067	+0·000465
,,	+0·000594	−0·000082	+0·000512
Mean	+0·000564	−0·000071	+0·000493

Comparison of RAS 0 . . . 1 Ft. with SS 24 . . . 36 Inches.

Date.	Observed Difference. RAS 0 . . . 1 Ft. = SS 24 . . . 36 Inches	Correction to reduce to 62° F.	At 62° F. RAS 0 . . . 1 Ft. = SS 24 . . . 36 Inches
1907	Inch.	Inch.	Inch.
July 8	+0·000603	−0·000058	+0·000545
,,	+0·000663	−0·000076	+0·000587
,,	+0·000644	−0·000055	+0·000589
,,	+0·000739	−0·000075	+0·000664
Mean	+0·000662	−0·000066	+0·000596

Comparison of RAS 1 . . . 2 Ft. with SS 24 . . . 36 Inches.

Date.	Observed Difference. RAS 1 . . . 2 Ft. = SS 24 . . 36 Inches	Correction to reduce to 62° F.	At 62° F. RAS 1 . . . 2 Ft. = SS 24 . . . 36 Inches
1907	Inch.	Inch.	Inch.
July 11	+0·000406	−0·000026	+0·000380
,,	+0·000477	−0·000038	+0·000439
,,	+0·000567	−0·000034	+0·000533
,,	+0·000478	−0·000058	+0·000420
,,	+0·000487	−0·000057	+0·000430
,,	+0·000505	−0·000073	+0·000432
Mean	+0·000487	−0·000048	+0·000439

Comparison of RAS 2 . . . 3 Ft. with SS 24 . . . 36 Inches.

Date.	Observed Difference. RAS 2 . . . 3 Ft. = SS 24 . . . 36 Inches	Correction to reduce to 62° F.	At 62° F. RAS 2 . . . 3 Ft. = SS 24 . . . 36 Inches
1907	Inch.	Inch.	Inch.
July 9	+0·000396	−0·000049	+0·000347
,,	+0·000422	−0·000095	+0·000327
,,	+0·000387	−0·000054	+0·000333
,,	+0·000417	−0·000091	+0·000326
Mean	+0·000405	−0·000072	+0·000333

In these reductions Baily's value for the expansion of the RAS scale has been used, viz. 1 foot expands 0·0002262 inch for 1° C.

From the above results we have, at 62° F.:—

RAS 0 . . . 1 ft. = SS 0 . . . 12 inches + 0·000463 inch.
RAS 0 . . . 1 ft. = SS 12 . . . 24 inches + 0·000493 inch.
RAS 0 . . . 1 ft. = SS 24 . . . 36 inches + 0·000596 inch.

∴ 3 (RAS 0 . . . 1 ft.) = SS 0 . . . 36 inches + 0·001552 inch,
but SS 0 . . . 36 inches = Imperial standard yard − 0·000153 inch.

∴ 3 (RAS 0 . . . 1 ft.) = Imperial standard yard + 0·001399 inch.
∴ (RAS 0 . . . 1 ft.) = ⅓ (Imperial standard yard) + 0·000466 inch.

Also from the comparisons with SS 24 . . . . 36 inches it follows that—

RAS 1 . . . 2 ft. = RAS 0 . . . 1 ft. − 0·000157 inch.
RAS 2 . . . 3 ft. = RAS 0 . . . 1 ft. − 0·000263 inch.

Hence

RAS 1 . . . 2 ft. = ⅓ (Imperial standard yard) + 0·000309 inch.
RAS 2 . . . 3 ft. = ⅓ (Imperial standard yard) + 0·000203 inch.

The sum of the values thus obtained for the three centre feet of the RAS scale gives—

RAS centre yard = Imperial standard yard + 0·000978 inch,

which differs somewhat from the result obtained from direct measurements of the centre yard, viz.—

RAS centre yard = imperial standard yard + 0·001050 inch.

If we combine the results of the observations made on the centre yard and on the separate feet, and regard the number of observations as the criterion of the relative weight of these results, we obtain the following adjusted values :—

RAS Centre yard = Imperial standard yard + 0·001046 inch.
RAS 0 . . . 1 ft = ⅓ (Imperial standard yard) + 0·000474 inch.
RAS 1 . . . 2 ft. = ⅓ (Imperial standard yard) + 0·000339 inch.
RAS 2 . . . 3 ft. = ⅓ (Imperial standard yard) + 0·000233 inch.

It remains to be seen how far the values of the three separate feet have changed relatively to one-third of the centre yard since the time of Baily's comparisons. From the results already given we obtain the following table :—

	Baily's Result, 1834.	Result, 1907.
	=⅓ RAS Centre Yard	
	Inch.	Inch.
RAS 0 . . . 1 ft.	+0·000125	+0·000125
RAS 1 . . . 2 ft.	−0·000037	−0·000009
RAS 2 . . . 3 ft.	−0·000088	−0·000116

Any variations which may have taken place in the lengths of the three separate feet relatively to one-third of the centre yard during the seventy-three years which have elapsed between the two determinations are, accordingly, well within the limits of errors of observation.

It appears very probable from the observations that Baily's value for the expansion of the RAS yard, viz. 0·0006786 for 1° C. is appreciably too great. If we adopt Airy's value, viz. 0·0006192 for 1° C., which seems a much more likely value, we obtain at 62° F.—

RAS Centre yard = Imperial standard yard + 0·001034 inch.
RAS 0 . . . 1 ft. = ⅓ (Imperial standard yard) + 0·000471 inch.
RAS 1 . . . 2 ft. = ⅓ (Imperial standard yard) + 0·000310 inch.
RAS 2 . . . 3 ft. = ⅓ (Imperial standard yard) + 0·000206 inch.

Combining these values as before we find—

RAS Centre yard = Imperial standard yard + 0·001032 inch.
RAS 0 . . . 1 ft. = ⅓ (Imperial standard yard) + 0·000476 inch.
RAS 1 . . . 2 ft. = ⅓ (Imperial standard yard) + 0·000330 inch.
RAS 2 . . . 3 ft. = ⅓ (Imperial standard yard) + 0·000226 inch.

as the adjusted values. It follows that—

RAS 0 . . . 1 ft. = ⅓ RAS Centre yard + 0·000132 inch.
RAS 1 . . . 2 ft. = ⅓ RAS Centre yard − 0·000014 inch.
RAS 2 . . . 3 ft. = ⅓ RAS Centre yard − 0·000118 inch.

These relative values do not differ from Baily's results by more than the probable errors of observation.

The defining lines on the RAS scale are between 0·0005 inch and 0·0006 inch in thickness, or nearly five times as thick as the lines on modern primary standards. The bar is, moreover, in the form of a hollow cylinder, constructed of three tubes drawn one within the other, and in this respect is quite dissimilar from modern standards. In spite of these defects, the fact that the relations between the three centre feet and one-third of the centre yard have not varied appreciably during the period of more than seventy years which has elapsed since Baily's investigation supports the contention that this measure and its subdivisions may be regarded as forming a standard scale, the lengths of the component parts of which bear to one another definite and invariable ratios. As the centre yard would appear to have grown appreciably longer since its previous comparison with the imperial standard yard, its absolute length cannot be regarded as invariable; but if its length be determined at any time, the corresponding lengths of the various subdivisions of the RAS scale may be at once obtained by merely multiplying their values, as deduced from Baily's results, by a numerical factor. In the case of the present determination the numerical factor would be the ratio of 36·001032 to 36·000376, or 1·000018.

The Royal Astronomical Society's 5-ft. tubular brass scale is at the premises of the Society in Burlington House. The other standards referred to above are deposited as follows:—The old imperial standard yard (Bird's standard yard of 1760) is in the custody of the Clerk of the House of Commons; the present imperial standard yard and the official bronze bar SS are in the custody of the Deputy Warden of the Standards, Old Palace Yard, Westminster.

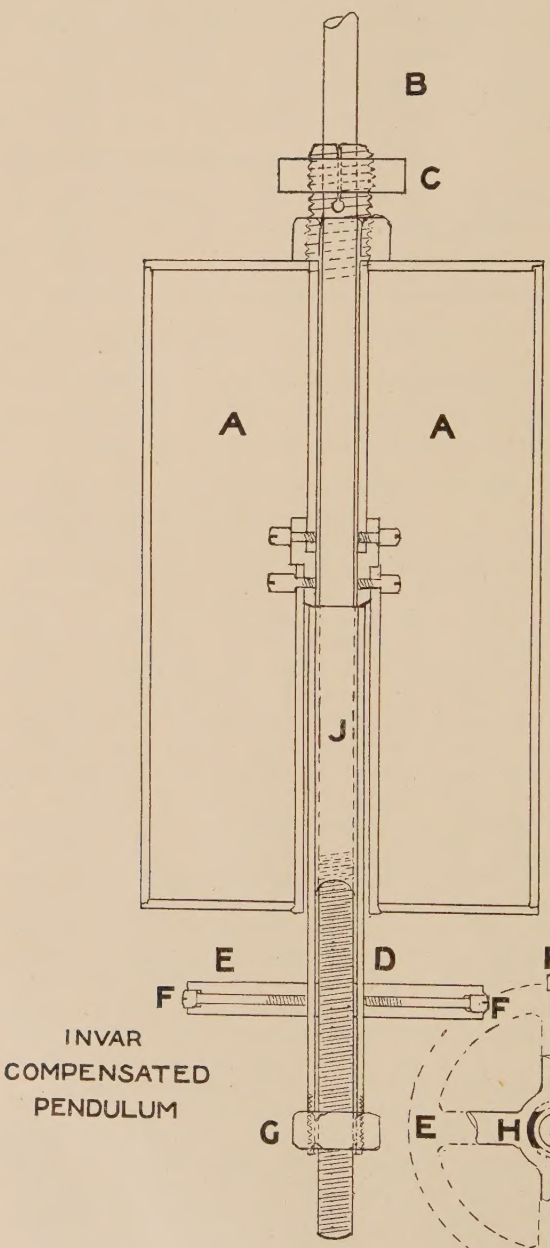


FIG. 1.

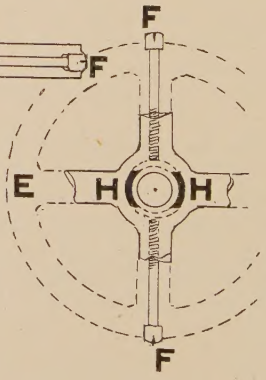


FIG. 2.

On an Adjustable Compensation for an "Invar" Pendulum.

By Richard Inwards.

Since the introduction of the alloy of steel and nickel called "Invar" it has been possible to make pendulums with a very short compensating tube, so that the whole instrument approaches the ideal form of a thin rod supporting a heavy weight.

Some Regulator clocks have been issued with "Invar" pendulums in which the temperature compensation is sought to be effected by the expansion of the bob itself, which is supported at such a place that the metal above the point of suspension expands and contracts to an extent calculated to balance the temperature variations in the length of the pendulum rod. This plan is open to weighty objections from a theoretical point of view, and it becomes a serious matter to alter the compensation if it should not have been correctly made at first.

It is clearly laid down in the late Lord Grimthorpe's book on clocks that the only proper point of support for the pendulum bob is at the centre of oscillation. This, in a 5-inch bob such as shown in the figure, is about $\frac{1}{5}$th of an inch below the centre of gravity of the bob.

The plan I now describe is designed to effect the compensation by a short tube of brass (J in fig. 1), and this is so made that it admits of being shortened or lengthened for exact adjustment by experiment, without taking the clock to pieces, and if over-corrected may be altered as many times as necessary without inserting new pieces of tube, as in the usual way, or altering the position of the bob on the pendulum rod. This is done by means of a timing-nut E which is attached to the brass compensating tube by two screws F F, and when these screws are loosened the nut can be raised or lowered about an inch (without turning the compensating tube) and clamped by the screws in any position finally decided on. The tube J is cut away at the two opposite sides, so as to pass through the curved slots in the timing-nut, as shown black at H in fig. 2. The nut is in the form of a light wheel, and has a hole tapped in the centre, which turns on a screwed part of the pendulum rod, as shown. The screw is of 18 threads to the inch, so that one turn corresponds to a minute a day in time.

On the top of the pendulum bob there is a grip-nut C on the principle of the self-centring drill-chuck, which on being tightened grasps the rod securely and holds the bob when the compensating brass tube is removed for alteration. This nut must, of course, be loosened when the tube has been put in.

The nut G at the bottom is to keep the ends of the slotted tube together, and may itself be used as a timing-nut for fractions of a second per day.

The pendulum rod shown has an expansion of about $\frac{1}{20}$th that of brass.

1911 *January* 7.

On a Periodic Discordance between the Right Ascensions of the Fundamental Catalogues and those of the Greenwich Standard Clock Stars. By W. G. Thackeray.

(*Communicated by the Astronomer Royal.*)

In the introduction to the Greenwich Second Nine-year Catalogue for 1900, p. 28, will be found a comparison between the right ascensions of the fundamental catalogues of Newcomb, Boss, and Auwers and those of the Greenwich standard clock stars. This comparison showed a small but well-marked discordance, varying with right ascension. This discordance Dr. Downing has referred to in the March number of the *Observatory* for 1910, and while he considers it "conceivable that part of the discordance may be due to the effect of magnitude equation," he concludes "it is highly improbable that such a connection would account for the whole or even for the greater part of the discordance in question."

To minimise the effect of magnitude correction, the Greenwich clock stars used in the following comparison have been limited to those between magnitude 3·0 and 4·9. The selection has been made according to the magnitudes given in the clock star list for 1910, which depend on the revised Harvard photometry and the Harvard photometry.

The fundamental catalogues have been compared with these selected Greenwich clock stars for a period extending over fifty years, at the following dates, 1860, 1872, 1880, 1890, 1900, and 1910.

The results for 1860 have been obtained by selecting those days in the years 1853–1867 on which at least six clock stars were observed extending over a period of 12 hours. New clock star lists were formed by carrying back the standard right ascensions of the Greenwich 1872 catalogue, reduced to Newcomb's equinox, with the precessions and proper motions given in Newcomb's fundamental catalogue for 1900; these new clock star places were compared with the clock star list places used in the reductions, and corrections were found to the original clock star places. These corrections were applied to the clock errors used on the selected days, and corrections for the new clock errors were applied to the original reductions. It was not found necessary to alter the adopted daily rates. The stars used for the period 1860 are somewhat fewer than those for the subsequent dates of comparison, and the number of observations for each star on the average is about 15.

For the dates 1872, 1880, 1890, and 1900, the Greenwich star places are the standard right ascensions of clock stars, based on 12-hour groups, printed at the end of the introductions to the successive Greenwich catalogues corresponding to those dates and referred to Newcomb's equinox. The corrections used to refer

these several standard positions to Newcomb's equinox are as follows:—

1872.	1880.	1890.	1900.
s	s	s	s
+ ·026	+ ·036	+ ·048	+ ·003

The Greenwich results for 1910 are derived from the observations made in the years 1906–7–8–9. They have been reduced to 1910, with Newcomb's precessions and proper motions, and have not been corrected to a system of 12-hour groups. As the difference between the 6-hour and 12-hour groups has been negligible for the last two catalogues, this will make no appreciable difference. The average number of observations for each star is about 15. Each fundamental catalogue place has been reduced to the epoch of the Greenwich standard right ascensions by the use of the centennial and secular variations given in that catalogue.

The discordances are given in the sense of Greenwich minus Newcomb, under the heading Newcomb, and similarly for the other catalogues, and are grouped for every 3 hours of right ascension.

The following table gives the number of stars of magnitude 3·0 – 4·9 for each 3 hours of right ascension for the period 1860, and for the other periods which are to be found in Newcomb's, Boss', and Auwers' catalogues.

Limits of RA.	No. of Stars, 1860 Catalogue.			No. of Stars, other Catalogue.		
	Newcomb.	Boss.	Auwers.	Newcomb.	Boss.	Auwers.
h h						
0– 3	10	10	10	15	15	12
3– 6	13	12	12	15	14	13
6– 9	11	8	9	15	12	12
9–12	10	10	9	11	11	10
12–15	11	11	11	12	12	12
15–18	13	11	11	14	12	12
18–21	20	16	16	21	17	16
21– 0	22	22	18	22	22	18
	110	100	96	125	115	105

The results of the comparison are given in the two following tables. The first gives the discordance for each period of comparison for each of the fundamental catalogues. The mean at the bottom of this table is found by giving equal weights to each group. The second table gives the same discordances grouped in order of date for each of the fundamental catalogues separately.

Corrections to the Fundamental Catalogues given by Greenwich Standard Right Ascensions of 3rd and 4th Magnitude Stars, referred to Newcomb's Equinox for each Date of Comparison.

Limits of R.A.	Corrections to Newcomb.	Boss.	Auwers.	Corrections to Newcomb.	Boss.	Auwers.	Corrections to Newcomb.	Boss.	Auwers.
	1860.			1872.			1880.		
h h	s	s	s	s	s	s	s	s	s
0– 3	– ·004	– ·001	·000	– ·008	– ·007	– ·003	– ·006	– ·005	– ·003
3– 6	·000	– ·001	+ ·003	+ ·003	+ ·005	+ ·011	– ·006	·000	+ ·003
6– 9	+ ·009	+ ·010	+ ·017	+ ·007	+ ·008	+ ·017	+ ·001	+ ·005	+ ·004
9–12	– ·002	+ ·003	+ ·009	+ ·006	+ ·008	+ ·011	+ ·006	+ ·007	+ ·009
12–15	– ·008	– ·005	– ·002	+ ·009	+ ·010	+ ·013	+ ·001	+ ·002	+ ·006
15–18	+ ·015	+ ·017	+ ·021	– ·003	– ·004	·000	– ·001	– ·001	+ ·004
18–21	– ·004	– ·006	– ·005	– ·003	– ·004	– ·002	·000	– ·002	+ ·001
21– 0	– ·005	– ·001	+ ·001	– ·010	– ·006	– ·003	+ ·004	+ ·007	+ ·008
Mean	·000	+ ·002	+ ·005	·000	+ ·001	+ ·005	·000	+ ·002	+ ·004
	1890.			1900.			1910.		
0– 3	– ·001	+ ·002	+ ·002	– ·004	·000	+ ·002	– ·002	+ ·003	+ ·002
3– 6	– ·006	+ ·001	+ ·002	– ·017	– ·010	– ·008	– ·020	– ·010	– ·008
6– 9	– ·012	– ·005	– ·003	– ·017	– ·007	– ·013	– ·026	– ·019	– ·024
9–12	+ ·003	+ ·001	+ ·002	+ ·008	+ ·004	+ ·004	+ ·007	+ ·001	– ·001
12–15	– ·003	– ·002	+ ·001	+ ·003	+ ·004	+ ·008	+ ·005	+ ·004	+ ·008
15–18	+ ·003	+ ·005	+ ·008	+ ·005	+ ·003	+ ·007	+ ·011	+ ·010	+ ·015
18–21	+ ·010	+ ·005	+ ·010	+ ·015	+ ·011	+ ·016	+ ·020	+ ·014	+ ·021
21– 0	+ ·005	+ ·006	+ ·009	+ ·008	+ ·008	+ ·015	+ ·004	+ ·002	+ ·008
Mean	·000	+ ·002	+ ·004	·000	+ ·002	+ ·004	·000	+ ·001	+ ·003

Corrections to each of the Fundamental Catalogues given by Greenwich Standard Right Ascensions of 3rd and 4th Magnitude Stars, referred to Newcomb's Equinox in order of date of comparison.

NEWCOMB.

Limits of R.A.	1860.	1872.	1880.	1890.	1900.	1910.
h h	s	s	s	s	s	s
0– 3	– ·004	– ·008	– ·006	– ·001	– ·004	– ·002
3– 6	·000	+ ·003	– ·006	– ·006	– ·017	– ·020
6– 9	+ ·009	+ ·007	+ ·001	– ·012	– ·017	– ·026
9–12	– ·002	+ ·006	+ ·006	+ ·003	+ ·008	+ ·007
12–15	– ·008	+ ·009	+ ·001	– ·003	+ ·003	+ ·005
15–18	+ ·015	– ·003	– ·001	+ ·003	+ ·005	+ ·011
18–21	– ·004	– ·003	·000	+ ·010	+ ·015	+ ·020
21– 0	– ·005	– ·010	+ ·004	+ ·005	+ ·008	+ ·004

Boss.

Limits of R.A.	1860.	1872.	1880.	1890.	1900.	1910.
h h	s	s	s	s	s	s
0– 3	– ·001	– ·007	– ·005	+ ·002	·000	+ ·003
3– 6	– ·001	+ ·005	·000	+ ·001	– ·010	– ·010
6– 9	+ ·010	+ ·008	+ ·005	– ·005	– ·007	– ·019
9–12	+ ·003	+ ·008	+ ·007	+ ·001	+ ·004	+ ·001
12–15	– ·005	+ ·010	+ ·002	– ·002	+ ·004	+ ·004
15–18	+ ·017	– ·004	– ·001	+ ·005	+ ·003	+ ·010
18–21	– ·006	– ·004	– ·002	+ ·005	+ ·011	+ ·014
21– 0	– ·001	– ·006	+ ·007	+ ·006	+ ·008	+ ·002

Auwers.

h h	s	s	s	s	s	s
0– 3	·000	– ·003	– ·003	+ ·002	+ ·002	+ ·002
3– 6	+ ·003	+ ·011	+ ·003	+ ·002	– ·008	– ·008
6– 9	+ ·017	+ ·017	+ ·004	– ·003	– ·013	– ·024
9–12	+ ·009	+ ·011	+ ·009	+ ·002	+ ·004	– ·001
12–15	– ·002	+ ·013	+ ·006	+ ·001	+ ·008	+ ·008
15–18	+ ·021	·000	+ ·004	+ ·008	+ ·007	+ ·015
18–21	– ·005	– ·002	+ ·001	+ ·010	+ ·016	+ ·021
21– 0	+ ·001	– ·003	+ ·008	+ ·009	+ ·015	+ ·008

As the results for the periods 1860 and 1910 depend on much fewer observations than those for 1872, 1880, 1890, and 1900, and in the case of the period 1860 on fewer stars also, the weights assigned to 1860 and 1910 results are 2 as compared with 5 to the others. Assuming that these discordances can be expressed in the form $x + Ty$, where x is the correction to the period 1880, and the unit of T is a century, thus making y the correction to the centennial variation, the solutions of the equations by least squares give the following:—

Limits of R.A.	Value of x for 1880.			Value of y.		
	Newcomb.	Boss.	Auwers.	Newcomb.	Boss.	Auwers.
h h	s	s	s	s	s	s
0– 3	– ·005	– ·002	·000	+ ·010	+ ·017	+ ·011
3– 6	– ·004	·000	+ ·003	– ·051	– ·031	– ·040
6– 9	– ·003	+ ·001	+ ·005	– ·076	– ·055	– ·090
9–12	+ ·004	+ ·004	+ ·007	+ ·011	– ·008	– ·023
12–15	+ ·002	+ ·003	+ ·006	+ ·002	– ·003	·000
15–18	+ ·003	+ ·004	+ ·007	+ ·008	+ ·004	+ ·005
18–21	+ ·004	+ ·001	+ ·004	+ ·054	+ ·044	+ ·056
21– 0	– ·002	+ ·001	+ ·004	+ ·039	+ ·027	+ ·036

It may be remarked, in conclusion, that the Greenwich Right

Ascensions at each date of comparison are the observed places within a year or so of the date, and therefore independent of proper motion. The mean epoch of observation of the fundamental catalogues is nearest the date of the 1872 catalogue, and therefore the factor which varies with the time is the number of years by which the annual variation has to be multiplied to reduce the fundamental catalogue place to the date of observation.

The values of y which are the corrections to the proper motions, especially at 3^h–9^h and 18^h–21^h, are of such a character that it seems impossible to resist the conclusion that either the fundamental catalogues or the Greenwich standard right ascensions are subject to considerable error.

On the Magnitude Equation of the Mean Greenwich Observer from a comparison of the Greenwich Standard Right Ascension of Clock Stars for 1900 *with Boss's Preliminary General Catalogue of* 6188 *Stars for* 1900.

By W. G. Thackeray.

(*Communicated by the Astronomer Royal.*)

The following table shows the direct result of the comparison of the two catalogues, with the name and magnitude of the star. The second table groups the discordances for each magnitude, and the two means at the bottom show the effect of applying the correction for periodic discordance arranged in hourly groups. The first mean (A) is the result of the uncorrected quantities, the second (B) after the correction has been applied.

The resulting magnitude equation is somewhat smaller for the bright stars than that derived from Boss's general formula $-0^s{\cdot}007\ (M-3{\cdot}5)$. The third table gives the smoothed hourly discordances and the mean magnitudes of the stars for each hour and three hours of R.A.

The probable value of the difference between the catalogues for a single star is $\pm 0^s{\cdot}009$.

TABLE I.

Comparison between the Standard Mean Right Ascension of Clock Stars in the Greenwich 1900 *Catalogue and Boss's General Catalogue of Stars* 1900.

Star's Name.	Mag.	Boss – Greenwich. Unit $^s{\cdot}001$. +	−	Star's Name.	Mag.	Boss – Greenwich. Unit $^s{\cdot}001$. +	−	Star's Name.	Mag.	Boss – Greenwich. Unit $^s{\cdot}001$. +	−
	0 *hrs.*			0 *hrs.*—contd.				1 *hr.*—contd.			
α Andr.	2·2	16		δ Pisc.	4·6		2	θ Ceti	3·8	2	
γ Peg.	2·9		2	20 Ceti	4·9		39	η Pisc.	3·7	16	
ι Ceti	3·8	3		μ Andr.	3·9	26		ν Pisc.	4·7	6	
44 Pisc.	6·0		22	ϵ Pisc.	4·5		11	o Pisc.	4·5		9
12 Ceti	6·0		17	1 *hr.*				β Arietis	2·7		10
ϵ Andr.	4·5	9		β Andr.	2·4	17		2 *hrs.*			
β Ceti	2·2		7	ζ Pisc.	5·6		25	α Arietis	2·2		7

TABLE I.—*continued.*

Star's Name.	Mag.	Boss – Greenwich. Unit s·001. +	−
2 *hrs.*—contd.			
ξ^1 Ceti	4·5		2
67 Ceti	5·7		12
ξ^2 Ceti	4·3		9
ν Ceti	5·0		25
δ Ceti	4·0	1	
γ^2 Ceti	3·6		15
σ Arietis	5·5		8
ϵ Arietis	4·6		3
α Ceti	2·8		7
3 *hrs.*			
δ Arietis	4·5	6	
τ^1 Arietis	5·2		15
o Tauri	3·8	1	
f Tauri	4·3	8	
ϵ Erid.	3·8	22	
11 Tauri	6·2		16
δ Erid.	3·7	13	
η Tauri	3·0		9
γ^1 Erid.	3·2	14	
A^1 Tauri	4·5	4	
4 *hrs.*			
w^1 Tauri	5·7	25	
o^1 Erid.	4·1	20	
γ Tauri	3·9	4	
ϵ Tauri	3·6	9	
Aldebaran	1·1	7	
τ Tauri	4·3	3	
μ Erid.	4·2	25	
i Aurigæ	2·9	22	
5 *hrs.*			
ϵ Leporis	3·3	23	
Rigel	0·3	14	
β Tauri	1·8	13	
δ Orion	2·5	3	
α Lep.	2·7	47	
ϵ Orion	1·8	20	
α Colum	2·8	35	

Star's Name.	Mag.	Boss – Greenwich. Unit s·001. +	−
5 *hrs.*—contd.			
κ Orion	2·2	10	
α Orion	1·0	1	
1 Gem.	4·3		6
6 *hrs.*			
ν Orion	4·4	16	
η Gem.	3·5	7	
μ Gem.	3·2	16	
β Can. Maj.	2·0	17	
ν Gem.	4·1		6
γ Gem.	1·9	7	
ξ Gem.	3·4	12	
θ Can. Maj.	4·3	27	
ϵ Can. Maj.	1·6	29	
ζ Gem.	4·0	27	
γ Can. Maj.	4·1	14	
7 *hrs.*			
51 Gem.	5·3		6
δ Gem.	3·5	26	
β Can. Min.	3·1	4	
Castor	2·0		7
Procyon	0·5	11	
Pollux	1·2	6	
ξ Argûs	3·5	25	
6 Cancri	5·0	15	
8 *hrs.*			
ρ Argûs	2·9	13	
β Cancri	3·8		10
d^1 Cancri	5·9		15
η Cancri	5·5		2
γ Cancri	4·7	10	
ϵ Hydræ	3·5	3	
α Cancri	4·3	10	
9 *hrs.*			
κ Cancri	5·3	11	
83 Cancri	6·6		10
α Hydræ	2·2	3	
ξ Leonis	5·1		10
o Leonis	3·8		2

Star's Name.	Mag.	Boss – Greenwich. Unit s·001. +	−
9 *hrs.*—contd.			
ϵ Leonis	3·1	3	
μ Leonis	4·1		26
π Leonis	4·9		5
10 *hrs.*			
Regulus	1·3		7
γ^1 Leonis	2·6		15
μ Hydræ	4·1	17	
ρ Leonis	3·9		6
34 Sext.	6·6		35
l Leonis	5·3		6
d Leonis	5·1		29
11 *hrs.*			
χ Leonis	4·7		8
δ Leonis	2·6	4	
δ Crateris	3·8		2
τ Leonis	5·2		4
υ Leonis	4·5		5
β Leonis	2·2	2	
β Virg.	3·8		5
π Virg.	4·6		18
12 *hrs.*			
o Virg.	4·2		13
ϵ Corvi	3·2	9	
η Virg.	4·0		6
δ^2 Corvi	3·1	27	
β Corvi	2·8	9	
ρ Virg.	5·0	5	
35 Virg.	6·7		22
31 Comæ	5·1		12
δ Virg.	3·7		13
ϵ Virg.	3·0		7
13 *hrs.*			
θ Virg.	4·4	1	
Spica	1·2		1
ζ Virg.	3·4		5
m Virg.	5·3		17

TABLE I.—*continued.*

Star's Name.	Mag.	Boss–Greenwich. Unit 8·001. +	−
13 *hrs.*—contd.			
τ Boötis	4·5		21
η Boötis	2·8	3	
τ Virg.	4·3	5	
14 *hrs.*			
94 Virg.	6·6		31
κ Virg.	4·3	1	
Arcturus	0·2	11	
f Boötis	5·4		5
ρ Boötis	3·8		14
ϵ^2 Boötis	2·7		7
α Libræ	2·9	24	
ζ^2 Libræ	5·6		19
15 *hrs.*			
ψ Boötis	4·7		16
ι Libræ	4·7	24	
β Libræ	2·7	12	
ω^2 Libræ	6·6		16
ζ Libræ	5·9	7	
α Coronæ	2·3		5
α Serp.	2·8		10
ϵ Serp.	3·8		4
γ Serp.	3·9		0
16 *hrs.*			
β^1 Scorpü	2·9	9	
δ Oph.	3·0	8	
γ Herc.	3·8		9
Antares	1·2	35	
λ Oph.	3·9		6
ζ Oph.	2·7	9	
ζ Herc.	3·0		12
κ Oph.	3·4		4
ϵ Herc.	3·9		5
17 *hrs.*			
η Oph.	2·6	12	
α^1 Herc.	3·5		2
θ Oph.	3·4	6	
σ Oph.	4·4		14
α Oph.	2·1	3	
β Oph.	2·9	1	
μ Herc.	3·5		7
89 Herc.	5·5		5
18 *hrs.*			
72 Oph.	3·7		24
μ Sag.	4·0	3	
η Serp.	3·4		10
λ Sag.	2·9	31	
α Lyræ	0·1	26	
2 Aquilæ	4·7		9
β^1 Lyræ	3·7		8
ϵ Aquilæ	4·2		29
19 *hrs.*			
ζ Aquilæ	3·0		17
ψ Sag.	4·9		20
ω Aquilæ	5·1		25
δ Aquilæ	3·4		13
α Vulpec.	4·6		22
μ Aquilæ	4·7		8
h^2 Sag.	4·7		9
e^1 Sag.	5·5		9
γ Aquilæ	2·8		10
α Aquilæ	0·9	1	
β Aquilæ	3·9		17
c Sag.	4·6		3
20 *hrs.*			
θ Aquilæ	3·4		5
α^2 Cap.	3·8		3
β Cap.	3·3		7
ρ Cap.	5·0		16
ϵ Delph.	4·0	1	
α Delph.	3·9		2
ϵ Aquarii	3·8		24
21 *hrs.*			
μ Aquarii	4·8		13
32 Vulpec.	5·2		38
θ Cap.	4·2	3	
ζ Cygni	3·4		16
α Equulei	4·1		1
ι Cap.	4·3	14	
β Aquarii	3·1		11
ξ Aquarii	4·8		2
ϵ Peg.	2·5		12
δ Cap.	3·0		0
16 Peg.	5·1		23
22 *hrs.*			
α Aquarii	3·2		15
ν Peg.	4·0		12
θ Aquarii	4·3		26
γ Aquarii	4·0		14
σ Aquarii	4·9	17	
η Aquarii	4·1		2
ζ Peg.	3·6		1
μ Peg.	3·7		11
λ Aquarii	3·8		11
Fomalhaut	1·3		15
α Peg.	2·6		6
γ Pisc.	3·9		15
23 *hrs.*			
κ Pisc.	4·9		1
ι Pisc.	4·3		17
δ Sculp.	4·6		34
ω Pisc.	4·0		7
2 Cetî.	4·6		20

Table II.

Comparison between Boss's General Catalogue 1900 *and Greenwich Standard R.A.'s* 1900, *arranged according to Magnitude. Boss – Greenwich.*

0·0–0·9		1·0–1·9		2·0–2·9		3·0–3·9		4·0–4·9		5·0–5·9		6·0–6·9	
+	–	+	–	+	–	+	–	+	–	+	–	+	–
14		7	7	16	2	3	15	9	2	25	25		22
11		13	1	17	7	26	9	6	39	15	12		17
11		20	15	22	10	2	10	1	11	11	25		16
26		1		3	7	16	2	6	9	5	8		10
1		7		47	7	1	2	8	2	7	15		35
		29		35	7	22	5	4	9		6		22
		6		10	15	13	13	20	3		15		31
		35		17	7	14	7	3	6		2		16
				13	5	4	5	25	6		10		
				3	10	9	14	16	10		6		
				4	10	23	4	27	26		29		
				2	12	7	0	27	5		4		
				9	6	16	9	14	8		12		
				3		12	6	10	5		17		
				24		26	12	17	18		5		
				12		4	4	1	13		19		
				9		25	5	5	6		5		
				9		3	2	1	21		25		
				12		3	0	24	16		9		
				3		9	7	3	14		16		
				1		27	24	1	9		38		
				31		8	10	3	29		23		
						6	8	14	20				
							17	17	22				
							13		8				
							17		9				
							5		3				
							3		13				
							7		1				
							2		2				
							24		12				
							16		26				
							11		14				
							0		2				
							15		1				
							1		17				
							11		34				
							11		7				
							15		20				

	s	s	s	s	s	s	s
Mean (A)	+·013	+·009	+·006	–·001	–·003	–·010	–·021
Mean (B)	+·012	+·003	+·006	+·001	·000	–·007	–·017
No. of stars	5	11	35	62	63	27	8

TABLE III.

Corrections for every Hour of R.A., and mean Magnitude of Stars for every Hour and every Three Hours of R.A.

Limits of R.A.	Correction.	Mean Magnitude of Group.		Limits of R.A.	Correction.	Mean Magnitude of Group.	
h h	s			h h	s		
0–1	−·007	4·1		12–13	−·005	4·1	
1–2	−·004	3·9	4·1	13–14	−·004	3·7	3·9
2–3	−·001	4·2		14–15	−·003	3·9	
3–4	+·004	4·2		15–16	−·002	4·2	
4–5	+·010	3·7	3·4	16–17	·000	3·1	3·6
5–6	+·013	2·3		17–18	−·002	3·5	
6–7	+·011	3·3		18–19	−·005	3·3	
7–8	+·007	3·0	3·6	19–20	−·008	4·0	3·8
8–9	+·001	4·4		20–21	−·009	4·1	
9–10	−·004	4·4		21–22	−·010	3·8	
10–11	−·006	4·1	4·1	22–23	−·010	3·7	3·9
11–12	−·006	3·9		23– 0	−·009	4·1	

Standard Mean Right Ascensions of Clock Stars for 1860·0 *based on Twelve-hour Groups, from Observations made with the Greenwich Transit Circle in the years* 1853–1867. By W. G. Thackeray.

(*Communicated by the Astronomer Royal.*)

It is well known that the Right Ascensions of all stars depend on the determination of the error of the clock. This clock error is based on the assumption that the R.A. of certain standard stars is known, and these standard stars are generally referred to as clock stars. As any periodic or systematic error in the adopted places of these stars passes by the use of the clock correction into the places of all other stars, it is very important that these clock star places should be very carefully determined. The difficulty of determining the R.A.'s of these clock stars can be seen from the following cases:—In the extreme case of a clock error being determined from a single star, it is apparent that the deduced clock error will only reproduce the assumed place of the star; in the case of a group of stars of much the same R.A., the mean of the group will be reproduced, and any error common to the group will be perpetuated. It is clear, therefore, that to prevent the introduction of periodic error, or to get rid of it, it is advisable, and indeed necessary, to derive the clock error from stars spread over a con-

siderable period of R.A., as well as to use a sufficient number of stars in a group.

In some way which has never been fully accounted for, a very unfortunate periodic error crept into the adopted Right Ascensions used at Greenwich between 1830 and 1840, and was reproduced in subsequent catalogues. It was to get rid of this error in the adopted Right Ascensions of the clock stars that, in the formation of the 1872 and subsequent Greenwich catalogues, special places of the clock stars were derived based on those determinations of R.A. which depended on a group of clock stars extending over twelve hours at least. By such an arrangement every clock star coming at the end of a night's watch depends on the place of clock stars extending over the previous twelve hours of R.A.; and when the same star is at the beginning of a night's watch, it depends on the place of clock stars extending over the succeeding twelve hours of R.A. Thus in the course of a year, provided the weather is fairly fine throughout the year—or, at any rate, in the course of a few years—when the twelve-hours groups would tend to be equally distributed throughout the different months, the mean R.A. of a clock star would depend on clock errors derived from not only neighbouring stars but stars of every R.A.

It was found on examining the observations made with the transit circle during the years 1853–1867 that there were 418 days on which the observations of clock stars extended over twelve hours, with a minimum of six stars and an average of ten stars per day—in fact, enough material to form new places of the clock stars for 1860·0 on the same basis as the Standard Mean Right Ascensions of the 1872 and succeeding catalogues. For this purpose new clock star lists were formed by carrying back the Standard Right Ascensions of the 1872 catalogue, reduced to Newcomb's equinox by a correction of $+0^{s}\cdot026$. The precessions and proper motions used in the reductions were those of Newcomb's Fundamental Catalogue for 1900. From a comparison of these new clock-star lists with those originally used in the reductions, corrections were formed to the old adopted places, and these corrections were applied to the clock errors used on the selected days of observations. These new clock errors were then applied in the form of corrections to the formerly deduced Right Ascensions, and the results were reledgered. It was not found necessary to alter the adopted daily rates. The results are given in the following table, with the mean date of observation and the number of observations. The magnitudes are taken from the 1910 clock star list, and depend on the Revised Harvard Photometry and the Harvard Photometry.

[Table.

Star's Name.	Mag.	Mean R.A. 1860·0. h	m	s	Mean Date of Obs. 1800+	No. of Obs.
α Andromedæ	2·2	0	1	9·458	61·31	49
γ Pegasi	2·9		6	1·807	61·65	37
ι Ceti	3·8		12	17·655	61·59	8
12 Ceti	6·0		22	53·691	58·39	13
ϵ Andromedæ	4·5		31	9·908	63·57	12
β Ceti	2·2		36	33·653	61·02	19
μ Andromedæ	3·9		48	59·666	61·89	22
ϵ Piscium	4·5	0	55	40·806	62·19	44
β Andromedæ	2·4	1	1	54·225	64·65	18
θ Ceti	3·8		17	1·563	59·32	42
η Piscium	3·7		23	59·822	60·99	32
ν Piscium	4·7		34	8·932	60·24	34
β Arietis	2·7		46	54·751	60·31	32
α Arietis.	2·2	1	59	17·303	59·22	50
67 Ceti	5·7	2	10	0·114	58·53	18
ξ^2 Ceti	4·3		20	43·158	59·47	21
δ Ceti	4·0		32	18·547	64·18	3
γ^2 Ceti	3·6		36	2·971	57·74	32
σ Arietis	5·5		43	46·121	58·82	18
α Ceti	2·8	2	54	57·835	58·31	29
δ Arietis	4·5	3	3	37·768	59·58	26
τ Arietis	5·2		13	9·011	61·85	13
o Tauri	3·8		17	16·956	58·46	15
f Tauri	4·3		23	8·894	61·14	11
ϵ Eridani	3·8		26	20·155	59·14	18
11 Tauri	6·2		32	24·981	60·71	8
δ Eridani	3·7		36	32·616	59·61	5
η Tauri	3·0		39	10·105	59·29	37
γ^1 Eridani	3·2	3	51	29·929	56·57	22
ω^1 Tauri	5·7	4	1	0·890	59·39	18
o^1 Eridani	4·1		5	1·974	59·40	5
γ Tauri	3·9		11	49·805	58·78	20
ϵ Tauri	3·6		20	26·724	59·29	32
Aldebaran	1·1		27	53·438	60·14	83
μ Eridani	4·2		38	30·265	60·37	17
ι Aurigæ	2·9		47	52·889	59·99	31
ϵ Leporis	3·3	4	59	32·127	60·54	15

Star's Name.	Mag.	Mean R.A. 1860·0. h	m	s	Mean Date of Obs. 1800+	No. of Obs.
Rigel	0·3	5	7	48·661	60·14	80
β Tauri	1·8		17	26·668	59·70	52
δ Orionis	2·5		24	51·301	60·88	21
α Leporis	2·7		26	33·358	57·80	8
ε Orionis	1·8		29	6·617	60·31	27
α Columbæ	2·8		34	34·792	58·65	11
κ Orionis	2·2		41	7·011	63·16	8
α Orionis	1·0		47	35·600	60·64	79
1 Geminorum	4·3		55	36·682	59·67	13
ν Orionis	4·4	5	59	34·736	60·42	8
η Geminorum	3·5	6	6	25·651	59·52	18
μ Geminorum	3·2		14	29·413	58·66	30
β Canis Majoris	2·0		16	32·083	61·76	3
γ Geminorum	1·9		29	37·410	63·60	20
θ Canis Majoris	4·3		47	41·140	60·16	17
ε Canis Majoris	1·6	6	53	7·450	56·07	5
51 Geminorum	5·3	7	5	19·838	63·34	5
δ Geminorum	3·5		11	45·560	59·56	28
β Canis Minoris	3·1		19	33·427	60·00	19
Castor	2·0		25	39·734	60·27	36
Pollux	1·2		36	44·687	59·64	73
ξ Argûs	3·5		43	24·383	61·38	4
6 Cancri	5·0	7	54	54·879	59·71	18
ρ Argus	2·9	8	1	34·959	59·15	8
β Cancri	3·8		8	55·232	58·91	10
d^1 Cancri	5·9		15	20·620	64·16	2
η Cancri	5·5		24	36·483	59·76	12
γ Cancri	4·7		35	10·784	57·64	19
ε Hydræ	3·5		39	21·586	57·49	18
α Cancri	4·3	8	50	49·631	60·38	15
κ Cancri	5·1	9	0	9·666	60·95	11
83 Cancri	6·6		11	9·820	59·64	14
α Hydræ	2·2		20	42·435	61·25	21
ξ Leonis	5·1		24	23·730	61·60	6
ο Leonis	3·8		33	40·559	62·64	7
ε Leonis	3·1		37	53·897	58·82	12
μ Leonis	4·1		44	47·681	57·15	8
π Leonis	4·9	9	52	48·753	61·18	13

Star's Name.	Mag.	Mean R.A. 1860·0. h	m	s	Mean Date of Obs. 1800+	No. of Obs.
Regulus	1·3	10	0	54·787	60·54	68
γ^1 Leonis	2·6		12	14·959	62·15	19
μ Hydræ	4·1		19	19·301	63·99	4
ρ Leonis	3·9		25	26·229	59·18	23
34 Sextantis	6·6		35	23·624	60·49	11
l Leonis	5·3		41	53·738	57·55	13
d Leonis	5·1		53	19·754	61·14	13
χ Leonis	4·7	10	57	47·626	59·24	14
δ Leonis	2·6	11	6	39·474	60·30	26
δ Crateris	3·8		12	20·648	60·53	4
τ Leonis	5·2		20	44·226	60·51	17
υ Leonis	4·5		29	46·874	63·72	10
β Leonis	2·2		41	54·998	62·93	35
π Virginis	4·6	11	53	41·904	62·84	9
ϵ Corvi	3·2	12	2	55·768	59·75	8
η Virginis	4·0		12	44·645	60·83	12
δ^2 Corvi	3·1		22	37·496	61·26	15
β Corvi	2·8		27	2·405	58·69	8
35 Virginis	6·7		40	43·747	63·30	9
δ Virginis	3·7		48	33·136	60·87	28
ϵ Virginis	3·0	12	55	12·472	65·06	24
θ Virginis	4·4	13	2	42·214	59·48	8
Spica	1·2		17	49·293	60·83	116
ζ Virginis	3·4		27	33·710	60·92	28
m Virginis	5·3		34	16·088	62·90	4
τ Boötis	4·5		40	36·584	61·77	7
η Boötis	2·8		48	1·146	62·88	30
τ Virginis	4·3	13	54	31·431	59·52	11
κ Virginis	4·3	14	5	25·912	60·68	10
Arcturus	0·2		9	16·631	61·34	90
f Boötis	5·4		19	56·688	62·02	6
ρ Boötis	3·8		25	47·781	61·93	16
ϵ^2 Boötis	2·7		38	52·410	61·74	43
α Libræ	2·9		43	8·318	59·12	19
ξ Libræ	5·6		49	10·573	62·47	3
ψ Boötis	4·7	14	58	26·847	59·86	10

Star's Name.	Mag.	Mean R.A. 1860·0. h	m	s	Mean Date of Obs. 1800+	No. of Obs.
β Libræ	2·7	15	9	28·654	62·65	20
o^2 Libræ	6·6		15	13·593	59·74	8
ζ^1 Libræ	5·9		20	21·984	60·34	12
α Coronæ	2·3		28	45·708	60·80	60
α Serpentis	2·8		37	22·476	61·04	33
ε Serpentis	3·8		43	50·352	60·13	6
γ Serpentis	3·9		49	59·366	61·11	3
β^1 Scorpii	2·9	15	57	18·072	59·34	8
δ Ophiuchi	3·0	16	7	0·739	58·18	16
γ Herculis	3·8		15	44·768	62·98	12
Antares	1·2		20	49·736	59·77	15
λ Ophiuchi	3·9		23	51·276	58·07	5
ζ Ophiuchi	2·7		29	27·168	60·61	11
ζ Herculis	3·0		36	0·595	60·69	23
κ Ophiuchi	3·4		51	2·577	59·47	16
ε Herculis	3·9	16	54	56·100	62·70	6
η Ophiuchi	2·6	17	2	21·110	61·29	11
α^1 Herculis	3·5		8	15·938	57·67	29
θ Ophiuchi	3·4		13	24·871	60·14	9
σ Ophiuchi	4·4		19	34·177	59·12	22
α Ophiuchi	2·1		28	26·253	60·40	62
β Ophiuchi	2·9		36	33·468	60·23	30
μ Herculis	3·5		40	58·892	61·18	28
89 Herculis	5·5	17	49	46·407	65·01	10
72 Ophiuchi	3·7	18	0	42·797	62·82	31
μ Sagittarii	4·0		5	23·482	59·64	19
η Serpentis	3·4		14	3·982	58·76	5
λ Sagittarii	2·9		19	19·928	62·21	7
α Lyræ	0·1		32	11·940	60·01	67
2 Aquilæ	4·7		34	36·420	63·52	3
β^1 Lyræ	3·7		44	54·738	58·90	37
ε Aquilæ	4·2		53	16·142	61·14	17
ζ Aquilæ	3·0	18	58	58·571	58·52	40
ψ Sagittarii	4·9	19	6	57·234	62·42	5
ω Aquilæ	5·1		11	14·743	58·11	14
δ Aquilæ	3·4		18	26·355	59·08	19
α Vulpeculæ	4·6		22	52·826	60·54	11
μ Aquilæ	4·7	19	27	15·042	59·30	18

Star's Name.	Mag.	Mean R.A. 1860·0. h	m	s	Mean Date of Obs. 1800+	No. of Obs.
h^2 Sagittarii	4·7	19	28	11·107	59·13	4
γ Aquilæ	2·8		39	36·241	59·50	56
α Aquilæ	0·9		43	57·147	58·60	79
β Aquilæ	3·9		48	26·170	59·90	25
c Sagittarii	4·6	19	54	2·695	57·97	15
θ Aquilæ	3·4	20	4	4·796	58·70	22
α^2 Capricorni	3·8		10	17·057	60·83	21
β Capricorni	3·3		13	8·575	61·96	10
ρ Capricorni	5·0		20	52·319	63·50	15
ϵ Delphini	4·0		26	31·489	58·22	18
α Delphini	3·9		33	8·144	60·40	21
ϵ Aquarii	3·8		40	5·688	60·13	13
32 Vulpeculæ	5·2		48	35·713	59·96	20
θ Capricorni	4·2	20	58	4·381	59·82	12
ζ Cygni	3·4	21	6	58·773	61·39	30
α Equulei	4·1		8	49·490	61·11	13
ι Capricorni	4·3		14	26·855	59·02	18
β Aquarii	3·1		24	11·194	60·09	19
ξ Aquarii	4·8		30	17·809	60·86	15
ϵ Pegasi	2·5		37	18·620	50·02	31
δ Capricorni	3·0		39	18·610	59·29	2
16 Pegasi	5·1		46	41·662	61·35	16
α Aquarii	3·2	21	58	35·536	60·18	22
ι Pegasi	4·0	22	0	29·792	61·22	4
θ Aquarii	4·3		9	26·628	62·59	25
γ Aquarii	4·0		14	25·456	59·57	14
σ Aquarii	4·9		23	14·172	64·33	6
η Aquarii	4·1		28	9·702	58·88	25
ζ Pegasi	3·6		34	28·857	58·44	17
μ Pegasi	3·7		43	14·998	58·89	12
λ Aquarii	3·8		45	18·549	58·31	8
Fomalhaut	1·3		49	54·424	59·25	25
α Pegasi	2·6	22	57	47·370	58·96	31
γ Piscium	3·9	23	9	54·511	59·73	23
κ Piscium	4·9		19	45·346	58·83	21
ι Piscium	4·3		32	45·033	59·01	17
δ Sculptoris	4·6		41	37·713	59·77	3
ω Piscium	4·0		52	7·464	60·96	32
2 Ceti	4·6	23	56	33·925	60·59	14

The following table contains the deduced hourly smoothed corrections to the Right Ascensions of the 1860 catalogue to reduce the Right Ascensions of that catalogue to the above system of twelve-hour groups:—

Corrections to the Right Ascensions of the Greenwich 1860 Catalogue from Twelve-hour Groups.

Limits of R.A.	Correction to R.A.'s 1860 Catalogue.	Limits of R.A.	Correction to R.A.'s 1860 Catalogue.
h h	s	h h	s
0– 1	+·037	12–13	+·010
1– 2	·031	13–14	·013
2– 3	·023	14–15	·016
3– 4	·018	15–16	·021
4– 5	·014	16–17	·027
5– 6	·010	17–18	·032
6– 7	·008	18–19	·036
7– 8	·007	19–20	·038
8– 9	·006	20–21	·041
9–10	·006	21–22	·043
10–11	·007	22–23	·044
11–12	+·008	23– 0	+·043

Note on the Visual Spectrum of an uncatalogued Red Star in Lacerta. By the Rev. T. E. Espin, B.A.

On December 30th, when observing stars in zones 51° and 52° north declination, a red star not in Argelander's charts was detected $0^m\ 7^s{\cdot}5$ following B.D. + 51° 3420, and about 2′ south of it. The spectroscope revealed the presence of bright lines, and as no known variable star was in this place as far as I was aware, the information was at once telegraphed to Greenwich. It was first seen in twilight, and estimated at 8·0 mag., but as red stars always appear fainter on a bright background, the probability is that it was a little under 7·0 mag. The spectroscope, consisting of a Hilger direct-vision compound prism of Jena glass, immediately in front of a positive eyepiece of about 200, showed an exceedingly bright line, presumed to be F, flanked on the more refrangible side by an enormous band, making the spectrum perfectly discontinuous. Then a bright band, and still further in the violet a line was suspected, probably the hydrogen line. In the yellow was a bright line, and between it and F three bands, with bright flutings between them. The prism does not deal well with the red end, but there seemed to be a strong band on the less refrangible side of the yellow

line, and, further in the red, possibly a bright line, probably the hydrogen line. The star is curiously situated on the base line of a triangle of 12-mag. stars, two being on each of the sides and one at the apex.

1911 Jan. 1st.—A somewhat hasty observation, as clouds were coming up, B.D. $+51^\circ$ 3420 taken as 8·7 mag., the red star estimated 7·8. The observations of the previous night with the spectroscope confirmed. The spectrum is neither type III. nor type IV.

Jan. 3rd. $5^h\ 10^m$ p.m. to $5^h\ 50^m$, with clouds at intervals.—Taking B.D. $+52^\circ$ 3257 as 8·1 the red is 7·7 mag. In the spectroscope F does not seem so prominent, nor is the spectrum so full of sharp contrasts. The great band on the more refrangible side of F does not seem so intense. The yellow line is well seen, and between it and F are several bright lines.

Jan. 6th. $5^h\ 0^m$ to $5^h\ 50^m$, magnitude 7·9.—Examined the spectrum carefully, but definition not good. I do not think F is as bright as it was; on the other hand, the yellow line seems more conspicuous. The bright and dark spaces in the spectrum do not appear in such strong contrast. The bright fluting on the less refrangible side of F seems to have increased in intensity.

Jan. 10th. $5^h\ 30^m$, magnitude 7·9.—Good definition. The hydrogen lines seem steadily growing fainter, and the bright fluting on the less refrangible side of F seems brighter.

From Dec. 30th. to Jan. 10th. I could not see any alteration in colour, although the star has diminished very considerably in brightness. I have been forcibly reminded of the spectrum of R Cygni in its bright line stage, only the details are much more pronounced. It seems possible that the object will be found to be an unusually bright maximum of a hitherto unknown variable star.

Observations of Nova Lacertæ made at the Cambridge Observatory. By Arthur R. Hinks, M.A.

The Kiel telegram announcing Mr. Espin's discovery was received at Cambridge at $7^h\ 45^m$ on December 31, but the night was cloudy.

On the next evening, 1911 January 1, the Nova was easily found, being immediately identified by its strong red colour, which was much like that of Nova Geminorum when first seen.

Further observations were made on January 2, 3, 6, and 7, generally with much interference by cloud.

I. *Photographic Magnitudes.*

With the Sheepshanks equatorial four plates have been taken.

973. 1911 Jan. $1^d{\cdot}3$ (S.T. $1^h\ 12^m$–$1^h\ 22^m$). Two exposures of 3^m and two of 1^m. Ilford Monarch plate backed.

974. 1911 Jan. $1^d{\cdot}3$ (S.T. $1^h\ 21^m$–$1^h\ 42^m$). Two exposures of 3^m and two of 1^m. Wratten's Panchromatic plate.

975. 1911 Jan. $6^d{\cdot}4$ (S.T. $4^h\ 42^m$–$4^h\ 51^m$). Two exposures of 3^m and two of 2^m. Panchromatic.

977. 1911 Jan. $7^d{\cdot}3$ (S.T. $2^h\ 19^m$–$2^h\ 26^m$). One exposure of $7^m\ 13^s$. Monarch.

Ten comparison stars surrounding the Nova were selected from the Harvard A.G. Catalogue. They were necessarily all fainter than the Nova, because the Nova was the brightest star in the field.

A preliminary examination and reduction of the plates showed that the photographic magnitudes of the comparison stars did not agree at all well with the Harvard A.G. or the B.D. magnitudes. It was therefore desirable to begin by revising the comparison star magnitudes.

The images were measured with the large measuring machine of the Observatory: in the eyepiece I have mounted a photometric scale, formed by giving a series of exposures on a star, in the geometrical progression with ratio $\sqrt{2{\cdot}512}$. If one gained the equivalent of a visual magnitude by increasing the exposure $2\frac{1}{2}$ times—which one does not—the difference between two consecutive images on any scale should correspond to half a magnitude. By bringing the image on the plate to the appropriate part of the scale, and moving it backwards and forwards, or up and down, between two scale images, I estimate the intensity of the plate image in fifths of the scale interval—that is, in what should be tenths of a magnitude, but are not.

The study of this scale is not yet complete, and to some extent the results given below are preliminary. So far as the study has gone, I have been unable to show that the relation between scale

readings and equivalent visual magnitudes is other than linear. But there is still considerable doubt as to the photometric equivalent of the scale intervals.

A series of Pleiades plates, reduced with Schwarzschild's magnitudes, derived from measuring the densities of extra-focal images (*Publ. v. Kuffner'sche Sternwarte*, Bd. v. p. C. 62), gave—

$$2 \text{ scale intervals} = 0^{m}\cdot 88.$$

The same plates reduced with Pickering's photographic magnitudes (*Harvard Annals*, vol. xviii. p. 156) gave—

$$2 \text{ scale intervals} = 0^{m}\cdot 65.$$

A considerable series of plates of the fields surrounding five long-period variables, reduced with Pickering's magnitudes (*Harvard Annals*, vol. xlvii. part i.), gave—

$$2 \text{ scale intervals} = 0^{m}\cdot 72.$$

I have independent evidence for believing that the first result from the extra-focal determinations is too high, and I have provisionally adopted—

$$\text{Exposure ratio } 2\cdot 512 = 2 \text{ scale intervals} = 0^{m}\cdot 69.$$

With this value of my scale interval I have obtained the following results for the photographic magnitudes of the selected comparison stars :—

TABLE I.

Star.	Harvard A.G. No.	B.D. No.	Visual Magnitudes. Harv.	B.D.	Photographic Magnitudes. Monarch.	Panchromatic.
A	7778	51°3415	8·8	9·0	8·72	8·70
B	7780	52°3243	9·1	9·0	9·70	10·00
C	7783	52°3245	8·8	8·7	8·82	8·93
D	7788	51°3420	8·8	8·7	8·56	8·48
E	7790	52°3247	8·2	8·3	8·27	8·24
F	7807	52°3251	9·3	...	10·20	10·36
G	7816	51°3428	9·1	9·0	9·69	9·81
H	7818	52°3252	9·0	8·9	9·32	9·31
K	7821	51°3433	8·9	9·0	8·71	8·67
L	7828	52°3257	8·4	8·1	8·82	8·82

The zero of the photographic magnitude scale was obtained by taking the mean magnitude of the six stars A, C, D, E, K, L = 8·65 (Harvard).

The photographic magnitudes of the Nova were then determined as follows :—The difference in the photographic scale readings for

the Nova and for each star separately were reduced by the ratio 2 intervals $= 0^m{\cdot}69$ and applied to the determined photographic magnitudes of the stars.

TABLE II.

Photographic Magnitudes of Nova Lacertæ, deduced from each Comparison Star separately.

Star.	Monarch Plates.			Panchromatic Plates.			
	973. Jan. 1.		977. Jan. 7.	974. Jan. 1.		975. Jan. 6.	
	3^m	1^m	7^m	3^m	1^m	3^m	1^m
A	7·91	7·60	7·71	7·64	7·35	7·29	7·30
C	7·87	7·63	7·70	7·60	7·27	7·52	7·29
D	7·81	7·61	7·79	7·49	7·24	7·55	7·42
E	7·70	7·91	7·60	7·49	7·34	7·52	7·36
K	7·83	7·59	7·80	7·65	7·29	7·43	7·34
L	7·94	7·46	7·81	7·56	7·10	7·44	7·42
	7·84	7·63	7·74	7·57	7·27	7·46	7·36
B	7·78	...	7·79	7·67	...	7·38	...
F	...	...	7·74	...	...	7·46	...
G	7·91	7·40	7·92	7·65	...	7·40	...
H	7·82	7·41	8·00	7·50	7·38	7·45	...

It will be noticed that there is a tendency for the magnitudes of the Nova deduced from the shorter exposures to be smaller (*i.e.* star brighter) than from the longer. The point has been examined, but no explanation found.

Taking for our final result the mean magnitudes given by the six stars which furnished our zero, we have for the magnitude of the Nova—

Monarch.		Panchromatic.	
	m		m
Jan. 1·3	7·74	Jan. 1·3	7·42
7·3	7·74	6·4	7·41

The surprising accordance is hardly warranted by the individual results. But we may conclude that the star is $0^m{\cdot}3$ brighter on Panchromatic plates (as might be anticipated from its red colour), and that there is no evidence of diminution in photographic magnitude between the dates given.

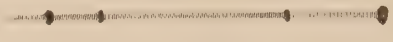
In comparing these results with others that may be given by other instruments, it should be remembered that the objective of the Sheepshanks telescope is a Cooke Photo-Visual.

II. *Spectrum.*

The spectrum of the star was examined visually with a small direct-vision prism held over the eyepiece. The following rough

notes may be of temporary interest, pending the publication of more serious work.

Four bright lines were seen superposed on a continuous spectrum.



By comparison with Campbell's figure of the spectrum of Nova Aurigæ (Frost's *Scheiner*, p. 284) the following identifications were hazarded:—

$$1 = H_\alpha;\ 2 = D_3;\ 3 = \lambda\ 5016;\ 4 = H_\beta.*$$

Line 1 was always a great deal the brightest.

The relative brilliance of the others was—

Jan. 1. $2 = 3$ decidedly > 4.
2. $3 > 2 > 4$, the last being not so conspicuous as on the previous day.
3. Glimpsed through clouds. No marked change.
6. $3 > 2 > 4$.
7. No considerable change since yesterday.

On each day I compared the relative brightness of the Nova and B.D. 51°3420 as seen (1) visually, (2) in the continuous spectrum as a whole. No considerable difference in the two ratios was remarked, and I conclude that the four bright lines do not contribute a large share to the total light of the Nova.

On January 1 the comparison star appeared decidedly green beside the Nova,—the contrast of colours nearly as marked as in γ Andromedæ.

On January 2 the visual magnitude of the Nova was estimated nearly $0^{m}.5$ fainter than on January 1. But no further decline was noticed.

* Note, added 1911 Jan. 21:—It appears from information given me later by Professor Newall and Mr. Stratton that this guess was wrong. 2 is not D_3 and $3 = H\beta$.

Cambridge Observatory:
1911 *January* 11.

Nova Lacertæ (Espin); Positions in R.A. and Dec., and also in Standard Co-ordinates of 300 Stars surrounding the Nova, from a Photograph taken at the University Observatory, Oxford. By F. A. Bellamy, M.A.

Notice of the discovery of this star about 5 P.M. on December 30, by the Rev. T. E. Espin, M.A., of Exeter College, Oxford, at his Wolsingham Observatory, Tow Law, near Darlington, was received late on the evening of December 31, which night was cloudy. On January 1, the night being unusually fine, I was enabled to obtain two photographs of the region, the second of which forms the subject of this paper.

The new star is in R.A. $22^h\ 32^m$ and Dec. $+52°\ 15'$, near the border of the constellation Lacerta towards Cepheus, and is situated in the Milky Way, where most of the discoveries of new stars have occurred; the number of such objects now exceeds twenty.

The instrument used was the 13-inch astrographic telescope with which the portion of the International Survey allotted to this Observatory was photographed, and the procedure throughout was much the same as that adopted during the progress of that work. The star when on the meridian at Oxford is half a degree northwards from the zenith and therefore circumpolar, but for greater convenience in using the instrument for an object near that position, the photographs were taken at about four hours west hour-angle on January 1 and 2, and the sidereal times for the mean exposures are—

		h m s		h m s		min. min.
Plate 2859, 1911, Jan.	1	2 11 25	and	2 17 10,	exposures	4, 6
,, 2860	1	2 40 25	,,	2 49 0	,,	6, 5
,, 2861	2	1 40 25	,,	1 49 0	,,	5, 10

Though the night of January 1 was exceptionally clear, there was a squally wind of about 35 miles an hour, blowing from the north-west, and so direct through the shutter-opening and upon the instrument, with the result that it shook the instrument, and not only rendered guiding troublesome, but prevented the photographic images being so round as usual; consequently the first and longer exposure on Plate 2860 was not used. The second exposure, giving quite satisfactory images for measurement, was adopted. The images of the first exposure on Plate 2859, also both on Plate 2861, are satisfactory, but no measures upon these plates have yet been made. It was intended to give a longer exposure to Plate 2861 on January 2, but that night was equally windy, with the addition of a considerable amount of cirrus cloud; for these two reasons only the short exposures were given. The area of the plate measured was limited to 15′ about the Nova, with the addition of stars found in the Harvard A.G.C. for plate

constants and a number of the brighter stars more widely scattered on the plate. These also serve for comparison of magnitude.

In the determination of the plate constants five stars from the Harvard A.G.C. were selected about each of the diagonal axes N.E., N.W., S.E., S.W., and were combined in pairs of groups to give the polar and equatorial mean groups; the plate centre adopted was $22^h\ 32^m + 52^\circ$. The measured positions were compared with the standard co-ordinates ξ' and η', calculated from the Harvard places, reduced to 1900·0, by means of MS. tables for 0° to $+64^\circ$, existing at this Observatory, and of similar construction to those already printed in the Astrographic Catalogues (Oxford) for $+25^\circ$ to $+31^\circ$, to which reference may be made for the formulæ used. The equations were solved in the usual way by successive approximations, and the residuals Oxford minus Harvard were formed for these twenty stars and for other Harvard stars.

TABLE I.

	Oxford–Harvard.					Oxford–Harvard.			
	x		*y*			*x*		*y*	
N.W.	7756	−·001		+·001	N.E. 7819	−·003		−·012	
	7762	−	2		0	7826		0	− 1
	7776	−	3	+	3	7852	−	3	0
	7783	+	3	+	1	7862	−	1	− 2
	7790	+	6	+	5	7865	+	6	+ 1
S.W.	7753	−	2		0	S.E. 7803	+	4	0
	7760	−	2	−	2	7829	−	1	+ 13
	7764	−	5	−	3	7845	−	1	+ 3
	7785	+	3	−	5	7852	+	4	− 1
	7799	+	3	−	3	7863	−	1	− 3
	7763	−	1	+	6	7807	−	2	− 9
	7766	−	2	+	1	7816	+	4	− 5
	7768	−	9	−	2	7818	−	1	− 2
	7778	+	2	−	5	7827	+	2	− 3
	7780		0	−	1	7828	−	1	− 2
	7786	−	8	+	4	7857	−	6	+ 1
	7788	−	2	−	1				

The mean epoch of the Harvard stars used is 1876; considering that the interval is thirty-four years, the residuals are very satisfactory. Of these twenty stars there are two stars, 7819 and 7829, which show some evidence of proper motion; 7819 was observed in 1877 and is the mean of two observations only, the difference $-3''\cdot6/33$ in dec. gives a small and uncertain P.M. of $-0''\cdot11$, and

7829, with the epoch 1872, the difference $+3''\cdot9/38$ in dec. gives a possible P.M. of $+0''\cdot10$; but the general accuracy of meridian observations does not justify one in placing much confidence in these two proper motions, as they are based upon such slender data.

Of the other Harvard stars measured, 7763, 7768, 7786, 7807, and 7865 show indications of small proper motions, and in the Introduction to Harvard A.G.C. (p. 37) the two stars 7790 and 7857 have μ and μ' given as $+0^s\cdot0043$ and $+0''\cdot028$ for 7790. Oxford measures give $+0^s\cdot0056$ and $+0''\cdot015$, and for 7857 the Harvard proper motions are $-0^s\cdot0018$ and $-0''\cdot044$, the Oxford amounts being $-0^s\cdot0041$ and $-0''\cdot009$; these results indicate uncertainty.

All the stars which showed certain images of both exposures within the selected area on Plate 2860 were measured by myself, first in the direct and then in the reversed position of the plate; the mean of the two measures was taken, the plate constants were applied, and the standard co-ordinates obtained; these were converted by the same tables to X's and Y's, or differences from the adopted plate centre, and the R.A.'s and Decs. deduced for 1900·0. It may be remarked that there are more than 5000 stars photographed in 5 min. within the $4\frac{1}{4}$ sq. deg. area which the boundary lines of the *réseau* includes.

The magnitude scale was deduced from a comparison of the Oxford mean measured diameters with the Harvard magnitudes of about 40 stars, all fainter than 8·0 mag. except one star, 7857, of 6·5 mag.; the formula used was $m = a - b\sqrt{d}$. d is the measured diameter in units of ·001 ($0''\cdot3$) of the *réseau*; a and b were found for this plate, and the photographic magnitude scale adopted is—

$$\text{photo-mag.} = 15\cdot9 - 1\cdot25\sqrt{d}.$$

A printed table, which will be included in the Introduction to the forthcoming vol. vii. of the Oxford Astrographic Catalogue, was used in finding the magnitude equivalent to the diameters. The measured photographic diameters do not show a good agreement with the Harvard estimates.

For the greater convenience in the comparison of the photographs that exist, or may be taken, with instruments of the same focal length, the standard co-ordinates ξ' and η' (expressed in *réseau* intervals for 1900·0) are given in Table III.; and the R.A.'s and Decs. are given for the convenience of those who still prefer those co-ordinates. Table II. contains the precessions and secular variations for 1900·0, computed from Dr. Downing's Tables (published in 1899 for 1910·0 epoch).

TABLE II.

Precessions and Secular Variations for 1900·0.

	R.A.							Dec.
	+51° 30′	+51° 40′	+51° 50′	+52° 0′	+52° 10′	+52° 20′	+52° 30′	
h m	s	s	s	s	s	s	s	″
22 29	+2·423	+2·419	+2·415	+2·411	+2·407	+2·403	+2·399	+18·487
22 30	·429	·426	·422	·418	·414	·410	·406	18·521
22 31	·436	·432	·428	·425	·421	·417	·413	18·554
22 32	·443	·439	·435	·432	·428	·424	·420	18·587
22 33	·450	·446	·442	·438	·435	·431	·427	18·620
22 34	·457	·453	·449	·445	·442	·438	·434	18·652
22 35	·463	·460	·456	·452	·449	·445	·441	18·684

The secular variation in R.A. is $+0^s·018$ for R.A. $22^h\ 29^m$ to $22^h\ 32^m$ for each declination and for $22^h\ 33^m + 51°\ 30'$ to $+51°\ 55'$; it is $+0^s·019$ for the rest of the table. The secular variation in dec. is $+0''·13$ for all decs. to R.A. $22^h\ 31^m$ and for $22^h\ 32^m$ to $+51°\ 50'$; for the rest of the table it is $+0''·12$. For Harvard stars outside these limits the precessions may be obtained from the catalogue.

The position of the Nova deduced from Plate 2860 is for

	h	m	s	°	′	″
1900·0	22	31	45·11	+52	11	55·4
1910·0		32	9·37		15	1·2
1911·0		32	11·80		15	19·8

and the precessions and secular variations for 1900·0 are for R.A. $+2^s·426 + 0^s·018$, for dec. $+18''·579 + 0''·12$.

ξ' and η' are equal to $\xi + 8·500$ R.I. and $\eta + 11·000$ R.I., and thus give the co-ordinates from the corner of the *réseau* when the adopted centre of the plate is $22^h\ 32^m + 52°$ (1900·0).

The measured diameter of the Nova is 54, which on the adopted scale is equal to 6·7 magnitude; the estimated magnitude on Jan. 2 was 7·5, and the colour of the star was noted as orange.

TABLE III.

Oxford. No.	Oxford. Meas. Diam.	Oxford. Mag.	Harvard. No.	Harvard. Mag.	Standard Co-ordinates. 1900·0. ξ'.	Standard Co-ordinates. 1900·0. η'.	Deduced R.A. 1900·0.	Deduced N. Dec. 1900·0.
					R.I.	R.I.	h m s	° ′ ″
1	18	10·6	7753	9·3	−0·314	7·705	22 27 15·46	+51 43 10·1
2	21	10·2	...		−0·307	7·835	22 27 15·62	51 43 49·2
3	38·5	8·2	7756	8·4	+0·307	15·288	22 27 31·74	52 21 7·4
4	36	8·4	7760	8·7	0·832	12·445	22 27 50·26	52 5 56·4
5	24·5	9·8	7762	8·4	1·294	17·248	22 28 3·18	52 30 59·6
6	47	7·3	7763	8·2	1·755	24·906	22 28 15·08	53 9 15·3
7	38·5	8·2	7764	9·0	1·554	3·988	22 28 17·28	51 24 43·3
8	24	9·8	7766	8·6	1·926	19·539	22 28 23 01	52 42 29·2
9	21	10·2	7768	9·3	1·943	19·564	22 28 23·56	52 42 36·8
10	32	8·8	7776	9·2	3·742	19·930	22 29 22·83	52 44 32·4
11	33	8·7	7778	8·8	4·756	12·624	22 29 58·01	52 8 3·3
12	12·5	11·5	...		5·074	9·732	22 30 8·63	51 53 36·3
13	16	10·9	...		5·112	14·306	22 30 9·26	52 16 28·6
14	6·5	12·7	...		5·116	11·750	22 30 9·92	52 3 41·8
15	20	10·3	...		5·126	12·810	22 30 10·03	52 8 59·8
16	11·5	11·7	...		5·131	10·735	22 30 10·61	51 58 37·3
17	4	13·4	...		5·142	10·081	22 30 11·10	51 55 21·1
18	6·5	12·7	...		5·189	11·999	22 30 12·24	52 4 56·6
19	6	12·8	...		5·192	11·210	22 30 12·50	52 0 59·9
20	10·5	11·9	...		5·221	15·728	22 30 12·54	52 23 35·3
21	5·5	13·0	...		5·207	12·212	22 30 12·79	52 6 0·6
22	4·5	13·3	...		5·250	16·262	22 30 13·38	52 26 15·6
23	11·5	11·7	...		5·250	12·608	22 30 14·11	52 7 59·4
24	12·5	11·5	...		5·310	10·968	22 30 16·38	51 59 47·6
25	16·5	10·8	...		5·364	12·360	22 30 17·87	52 6 45·2
26	3·5	13·6	...		5·434	16·004	22 30 19·47	52 24 58·5
27	21·2	10·1	7780	9·1	5·477	14·262	22 30 21·20	52 16 15·7
28	13	11·4	...		5·481	11·794	22 30 21·78	52 3 55·7
29	5	13·1	...		5·488	10·223	22 30 22·29	51 56 4·3
30	5·5	13·0	...		5·533	15·987	22 30 22·71	52 24 53·6
31	6·5	12·7	...		5·525	13·020	22 30 22·99	52 10 3·5
32	6·5	12·7	...		5·542	14·432	22 30 23·29	52 17 7·1
33	10·5	11·9	...		5·539	7·883	22 30 24·37	51 44 22·5
34	13	11·4	...		5·565	11·684	22 30 24·54	52 3 22·8
35	7	12·6	...		5·609	15·326	22 30 25·33	52 21 33·4

TABLE III.—*continued.*

Oxford. No.	Oxford. Meas. Diam.	Oxford. Mag.	Harvard. No.	Harvard. Mag.	Standard Co-ordinates. 1900·0. ξ'.	Standard Co-ordinates. 1900·0. η'.	Deduced R.A. 1900·0.	Deduced N. Dec. 1900·0.
					R.I.	R.I.	h m s	° ′ ″
36	4	13·4	...		5·655	10·760	22 30 27·62	51 58 45·7
37	5	13·1	...		5·694	11·940	22 30 28·69	52 4 39·8
38	4·5	13·3	...		5·741	14·148	22 30 29·05	52 15 42·2
39	7	12·6	...		5·744	16·451	22 30 29·55	52 27 13·1
40	7	12·6	...		5·723	10·969	22 30 29·80	51 59 48·5
41	4	13·4	...		5·738	13·421	22 30 29·87	52 12 4·1
42	12	11·6	...		5·748	13·829	22 30 30·13	52 14 6·5
43	4·5	13·3	...		5·768	12·985	22 30 30·92	52 9 53·4
44	6	12·8	...		5·795	15·335	22 30 31·41	52 21 38·5
45	14	11·2	...		5·784	10·644	22 30 31·83	51 58 11·2
46	17	10·7	...		5·836	16·399	22 30 32·58	52 26 57·7
47	8	12·4	...		5·821	10·679	22 30 33·03	51 58 21·7
48	5·5	13·0	...		5·835	13·054	22 30 33·10	52 10 14·2
49	5	13·1	...		5·832	8·967	22 30 33·66	51 49 48·1
50	10	12·0	...		5·839	9·605	22 30 33·78	51 52 59·5
51	7	12·6	...		5·858	12·228	22 30 33·98	52 6 6·5
52	6	12·8	...		5·891	16·193	22 30 34·42	52 25 56·0
53	15	11·1	...		5·870	11·168	22 30 34·54	52 0 48·5
54	4	13·4	...		5·869	10·385	22 30 34·63	51 56 53·6
55	7·5	12·5	...		5·884	9·517	22 30 35·25	51 52 33·2
56	12	11·6	...		5·926	9·737	22 30 36·39	51 53 39·3
57	3·5	13·6	...		5·937	12·597	22 30 36·49	52 7 57·3
58	15	11·1	...		5·950	13·224	22 30 36·82	52 11 5·4
59	11·5	11·7	...		5·994	14·247	22 30 38·10	52 16 12·3
60	6	12·8	...		5·995	13·797	22 30 38·20	52 13 57·3
61	8·5	12·3	...		5·976	15·787	22 30 38·27	52 23 54·3
62	11·5	11·7	...		5·994	10·137	22 30 38·72	51 55 39·4
63	4	13·4	...		6·034	10·815	22 30 39·92	51 59 2·8
64	12	11·6	...		6·054	15·010	22 30 39·94	52 20 1·3
65	7	12·6	...		6·050	11·145	22 30 40·39	52 0 41·8
66	5	13·1	...		6·057	12·146	22 30 40·47	52 5 42·1
67	4	13·4	...		6·110	16·126	22 30 41·61	52 25 36·2
68	7·5	12·5	...		6·183	12·291	22 30 44·55	52 6 25·8
69	3·5	13·6	...		6·338	15·978	22 30 49·11	52 24 52·1
70	7	12·6	...		6·324	11·411	22 30 49·26	52 2 2·0

TABLE III.—*continued.*

Oxford. No.	Oxford. Meas. Diam.	Oxford. Mag.	Harvard. No.	Harvard. Mag.	Standard Co-ordinates. 1900·0. ξ'. R.I.	Standard Co-ordinates. 1900·0. η'. R.I.	Deduced R.A. 1900·0. h m s	Deduced N. Dec. 1900·0. ° ′ ″
71	5	13·1	...		6·351	9·896	22 30 50·33	51 54 27·5
72	7	12·6	...		6·353	11·161	22 30 52·23	52 0 47·1
73	8	12·4	...		6·423	11·567	22 30 52·46	52 2 48·9
74	7	12·6	...		6·432	11·601	22 30 52·75	52 2 59·1
75	4·5	13·3	...		6·427	10·175	22 30 52·76	51 55 51·3
76	8	12·4	...		6·508	15·831	22 30 54·70	52 24 8·1
77	19	10·4	...		6·548	16·682	22 30 55·91	52 28 23·5
78	30·5	9·0	7783	8·8	6·573	16·682	22 30 56·73	52 28 23·5
79	9·5	12·1	...		6·629	12·730	22 30 59·02	52 8 38·0
80	6	12·8	...		6·634	11·288	22 30 59·35	52 1 25·4
81	9·5	12·1	..		6·655	15·787	22 30 59·53	52 23 55·1
82	30	9·1	...		6·671	11·294	22 31 0·55	52 1 27·3
83	4·5	13·3	...		6·689	13·617	22 31 0·88	52 13 4·2
84	27·5	9·4	...		6·804	22·251	22 31 3·73	52 56 14·2
85	10	12·0	...		6·779	12·781	22 31 3·91	52 8 53·5
86	5	13·1	...		6·814	13·376	22 31 4·99	52 11 52·0
87	5	13·1	...		6·875	9·691	22 31 7·34	51 53 26·5
88	5	13·1	...		6·963	15·870	22 31 9·61	52 24 20·3
89	13·5	11·3	...		6·975	11·145	22 31 10·45	52 0 42·8
90	5·5	13·0	...		6·984	10·603	22 31 10·79	51 58 0·3
91	4·5	13·3	....		6·992	10·535	22 31 11·05	51 57 39·9
92	12·5	11·5	...		6·688	9·807	22 31 11·27	51 54 1·2
93	39·5	8·1	7785	8·7	7·003	3·877	22 31 12·01	51 24 22·4
94	11·5	11·7	...		7·035	13·463	22 31 12·19	52 12 18·3
95	8	12·4	...		7·049	16·307	22 31 12·39	52 26 31·5
96	23	9·9	...		7·092	13·482	22 31 14·05	52 12 24·0
97	16	10·9	...		7·112	10·344	22 31 14·97	51 56 42·7
98	5	13·1	...		7·125	11·847	22 31 15·26	52 4 13·6
99	29·5	9·2	7786	8·8	7·162	24·796	22 31 15·39	53 8 57·8
100	11	11·8	...		7·142	14·847	22 31 15·57	52 19 13·6
101	4	13·4	...		7·153	14·417	22 31 15·96	52 17 4·6
102	5	13·1	...		7·194	9·567	22 31 17·69	51 52 49·6
103	5·5	13·0	...		7·254	14·369	22 31 19·27	52 16 50·3
104	4	13·4	...		7·259	15·253	22 31 19·36	52 21 15·5
105	11	11·8	...		7·263	15·503	22 31 19·48	52 22 30·5

TABLE III.—*continued.*

Oxford. No.	Oxford. Meas. Diam.	Oxford. Mag.	Harvard. No.	Harvard. Mag.	Standard Co-ordinates. 1900·0. ξ'. R.I.	Standard Co-ordinates. 1900·0. η'. R.I.	Deduced R.A. 1900·0. h m s	Deduced N. Dec. 1900·0. ° ′ ″
106	12	11·6	...		7·276	10·656	22 31 20·26	51 58 16·3
107	16·5	10·8	...		7·277	10·824	22 31 20·28	51 59 6·8
108	8	12·4	...		7·295	11·690	22 31 20·80	52 3 26·6
109	9	12·2	...		7·308	13·759	22 31 21·08	52 13 47·3
110	14	11·2	...		7·331	10·403	22 31 22·07	51 57 0·5
111	3·5	13·6	...		7·338	12·908	22 31 22·12	52 9 32·0
112	8	12·4	...		7·740	15·608	22 31 25·08	52 23 2·2
113	5	13·1	...		7·424	10·087	22 31 25·11	51 55 26·8
114	4	13·4	...		7·434	14·187	22 31 25·56	52 15 55·8
115	16	10·9	...		7·498	13·559	22 31 27·29	52 12 47·4
116	24·5	9·8	...		7·491	8·343	22 31 27·38	51 46 42·6
117	10·5	11·9	...		7·589	14·382	22 31 30·22	52 16 54·4
118	10	12·0	...		7·601	10·761	22 31 30·81	51 58 48·1
119	11	11·8	...		7·561	16·184	22 31 31·20	52 25 54·9
120	10·5	11·9	...		7·641	13·668	22 31 31·96	52 13 20·2
121	19·5	10·4	...		7·653	16·180	22 31 32·22	52 25 53·7
122	6	12·8	...		7·665	14·364	22 31 32·70	52 16 49·1
123	15	11·1	...		7·687	14·497	22 31 33·42	52 17 28·9
124	12·5	11·5	...		7·708	15·065	22 31 34·08	52 20 19·3
125	13	11·4	...		7·713	15·644	22 31 34·21	52 23 13·0
126	4	13·4	...		7·724	14·745	22 31 34·61	52 18 43·3
127	8	12·4	...		7·754	11·306	22 31 35·75	52 1 31·7
128	12·5	11·5	...		7·769	13·354	22 31 36·15	52 11 46·1
129	36·5	8·4	7788	8·8	7·802	13·710	22 31 37·21	52 13 32·9
130	8·5	12·3	...		7·815	9·430	22 31 37·81	51 52 8·9
131	13·5	11·3	...		7·864	7·484	22 31 39·47	51 43 9·5
132	36	8·4	7790	8·2	7·886	19·224	22 31 39·74	52 41 7·0
133	14	11·2	...		7·898	9·534	22 31 40·60	51 52 40·1
134	4	13·4	...		7·908	10·936	22 31 40·77	51 59 40·7
135	5·5	13·0	...		7·908	9·638	22 31 40·82	51 53 11·3
136	4	13·4	...		7·913	13·008	22 31 40·86	52 10 2·3
137	6·5	12·7	...		7·922	13·560	22 31 41·13	52 12 47·9
138	21	10·2	...		7·972	15·981	22 31 42·69	52 23 14·2
139	5·5	13·0	...		7·973	13·801	22 31 42·79	52 14 0·2
140	15	11·1	...		7·985	10·540	22 31 43·28	51 57 41·9

TABLE III.—*continued.*

Oxford. No.	Oxford. Meas. Diam.	Oxford. Mag.	Harvard. No.	Harvard. Mag.	Standard Co-ordinates. 1900·0. ξ'.	Standard Co-ordinates. 1900·0. η'.	Deduced R.A. 1900·0. h m s	Deduced N. Dec. 1900·0. ° ′ ″
					R.I.	R.I.		
141	9·5	12·1	...		8·029	13·657	22 31 44·62	52 13 17·0
142	5	13·1	...		8·037	11·042	22 31 44·96	52 0 12·5
143	8	12·4	...		8·041	10·073	22 31 45·11	51 55 22·8
	Nova Lacertæ				8·044	13·385	22 31 45·11	52 11 55·4
144	15·5	11·0	...		8·058	14·579	22 31 45·55	52 17 53·6
145	19	10·4	...		8·056	11·286	22 31 45·57	52 1 25·7
146	3	13·7	...		8·078	15·205	22 31 46·51	52 21 1·4
147	4	13·4	...		8·134	16·149	22 31 48·00	52 25 44·6
148	4·5	13·3	...		8·153	13·738	22 31 48·67	52 13 41·4
149	5	13·1	...		8·158	13·522	22 31 48·84	52 12 36·6
150	4	13·4	...		8·162	15·184	22 31 48·93	52 20 55·2
151	19·5	10·4	...		8·168	9·453	22 31 49·25	51 52 15·9
152	5	13·1	...		8·176	12·503	22 31 49·42	52 7 30·9
153	7	12·6	...		8·190	14·925	22 31 49·86	52 19 37·5
154	4	13·4	...		8·193	11·214	22 31 50·05	52 1 4·2
155	20	10·3	...		8·201	14·963	22 31 50·21	52 19 48·9
156	8·5	12·3	...		8·248	13·429	22 31 51·78	52 12 8·7
157	9·5	12·1	...		8·716	10·639	22 31 52·99	51 58 11·7
158	6	12·8	...		8·308	9·513	22 31 53·78	51 52 33·9
159	10	12·0	...		8·312	10·074	22 31 53·90	51 55 22·2
160	8·5	12·3	...		8·348	14·946	22 31 55·03	52 19 43·8
161	6	12·8	...		8·373	10·028	22 31 55·88	51 55 8·4
162	7	12·6	...		8·623	15·397	22 31 55·97	52 21 59·1
163	9·5	12·1	...		8·409	15·592	22 31 57·02	52 22 57·6
164	4	13·4	...		8·454	10·262	22 31 58·51	51 56 18·6
165	6·5	12·7	...		8·464	16·352	22 31 58·82	52 26 45·6
166	4·5	13·3	...		8·470	11·657	22 31 59·02	52 3 17·1
167	5·5	13·0	...		8·479	9·988	22 31 59·32	51 54 56·4
168	4·5	13·3	...		8·493	10·351	22 31 59·77	51 56 45·3
169	3·5	13·6	...		8·513	9·921	22 32 0·42	51 54 36·3
170	6·5	12·7	...		8·543	9·893	22 32 1·39	51 54 28·6
171	7	12·6	...		8·611	16·301	22 32 3·64	52 26 30·3
172	8	12·4	...		8·705	16·340	22 32 6·73	52 26 42·0

TABLE III.—*continued.*

Oxford. No.	Oxford. Meas. Diam.	Oxford. Mag.	Harvard. No.	Harvard. Mag.	Standard Co-ordinates. 1900·0. ξ'.	Standard Co-ordinates. 1900·0. η'.	Deduced R.A. 1900·0. h m s	Deduced N. Dec. 1900·0. ° ′ ″
					R.I.	R.I		
173	5	13·1	...		8·714	11·796	22 32 6·96	52 3 58·8
174	7	12·6	...		8·807	12·638	22 32 10·00	52 8 11·4
175	7	12·6	...		8·810	12·683	22 32 10·10	52 8 24·9
176	6·5	12·7	...		8·823	15·586	22 32 10·58	52 22 55·7
177	5	13·1	...		8·828	15·307	22 32 10·74	52 21 35·1
178	9	12·2	...		8·850	9·456	22 32 11·34	51 52 16·8
179	4·5	13·3	...		8·871	11·499	22 32 12·06	52 2 29·7
180	8·5	12·3	...		8·902	12·797	22 32 13·10	52 8 59·1
181	9	12·2	...		8·923	9·565	22 32 13·70	51 52 49·4
182	3·5	13·6	...		8·972	15·201	22 32 15·45	52 21 0·2
183	7·5	12·5	...		9·016	9·770	22 32 16·72	51 53 50·9
184	20	10·3	...		9·021	15·455	22 32 17·07	52 22 16·4
185	6	12·8	...		9·034	16·161	22 32 17·52	52 25 48·2
186	4	13·4	..		9·074	10·619	22 32 18·63	51 58 5·6
187	14·5	11·2	...		9·107	14·961	22 32 19·87	52 19 48·2
188	3·5	13·6	...		9·137	10·758	22 32 20·68	51 58 47·3
189	12	11·6	...		9·155	13·434	22 32 21·37	52 12 10 1
190	12·5	11·5	...		9·162	14·876	22 32 21·66	52 19 22·7
191	7	12·6	...		9·114	11·159	22 32 21·90	52 0 47·6
192	7	12·6	...		9·178	12·133	22 32 22·07	52 5 39·8
193	9·5	12·1	...		9·175	16·213	22 32 22·14	52 26 3·8
194	10·5	11·9	...		9·204	13·285	22 32 22·97	52 11 25·4
195	12·5	11·5	...		9·249	14·341	22 32 24·48	52 16 42·2
196	21·5	10·1	...		9·263	9·970	22 32 24·74	51 54 50·8
197	12	11·6	...		9·263	12·474	22 32 24·85	52 7 22·1
198	5	13·1	...		9·295	16·048	22 32 26·07	52 25 14·2
199	9	12·2	...		9·306	9·456	22 32 26·11	51 52 16·9
200	8	12·4	...		9·309	12·163	22 32 26·34	52 5 48·7
201	4·5	13·3	...		9·329	11·508	22 32 26·96	52 2 32·2
202	19	10·4	...		9·642	11·221	22 32 27·11	52 1 5·9
203	5	13·1	...		9·340	13·743	22 32 27·43	52 13 42·7
204	22	10·0	...		9·373	8·532	22 32 28·23	51 47 39·4
205	4	13·4	...		9·409	13·123	22 32 29·65	52 10 36·7

TABLE III.—*continued.*

Oxford.			Harvard.		Standard Co-ordinates. 1900·0.		Deduced				
							R.A. 1900·0.			N. Dec. 1900·0.	
No.	Meas. Diam.	Mag.	No.	Mag.	ξ'.	η'.	h	m	s	°	′ ″
					R.I.	R.I.					
206	5·5	13·0	...		9·477	12·191	22	32	31·81	52	5 57·0
207	3·5	13·6	...		9·498	16·078	22	32	32·73	52	25 23·1
208	14	11·2	...		9·543	12·637	22	32	33·99	52	8 10·8
209	4·5	13·3	...		9·546	13·801	22	32	34·16	52	14 0·0
210	18	10·6	...		9·587	11·612	22	32	35·35	52	3 3·3
211	15·5	11·0	...		9·601	10·491	22	32	35·73	51	57 27·0
212	5·5	13·0	...		9·595	13·833	22	32	35·76	52	14 9·6
213	4·5	13·3	...		9·616	10·811	22	32	36·24	51	59 3·0
214	11	11·8	...		9·634	11·445	22	32	36·87	52	2 13·1
215	9·5	12·1	...		9·676	13·331	22	32	38·37	52	11 38·9
216	9	12·2	...		9·690	14·617	22	32	38·92	52	18 4·7
217	18·5	10·5	7799	9·6	9·765	10·566	22	32	41·07	51	57 49·3
218	4·5	13·3	...		9·765	16·380	22	32	41·40	52	26 53·5
219	8·5	12·3	...		9·786	12·919	22	32	41·93	52	9 35·2
220	7·5	12·5	...		9·781	15·202	22	32	41·94	52	21 0·1
221	6·5	12·7	...		9·829	14·220	22	32	43·43	52	16 5·5
222	10	12·0	...		9·864	14·233	22	32	44·58	52	16 9·4
223	25	9·7	...		9·845	21·735	22	32	44·58	52	53 39·8
224	3·5	13·6	...		9·927	10·665	22	32	46·33	51	58 18·9
225	9	12·2	...		9·962	13·441	22	32	47·70	52	11 41·7
226	9	12·2	...		9·993	10·584	22	32	48·46	51	57 54·6
227	15·5	11·0	...		10·011	15·144	22	32	49·14	52	20 42·6
228	5	13·1	...		10·024	15·005	22	32	49·88	52	20 0·8
229	4	13·4	...		10·043	16·223	22	32	50·62	52	26 6·2
230	15	11·1	...		10·078	10·507	22	32	51·21	51	57 31·4
231	4	13·4	...		10·075	14·902	22	32	51·55	52	19 29·9
232	5·5	13·1	...		10·105	16·372	22	32	52·67	52	26 50·9
233	4	13·4	...		10·150	9·911	22	32	53·49	51	54 32·5
234	20·5	10·2	...		10·161	9·732	22	32	53·83	51	53 38·8
235	7	12·6	...		10·162	12·101	22	32	54·10	52	5 29·5
236	3·5	13·6	...		10·210	11·482	22	32	55·60	52	2 23·8
237	5·5	13·0	...		10·211	12·497	22	32	55·74	52	7 28·3
238	20	10·3	...		10·244	12·970	22	32	56·82	52	9 50·1
239	5·5	13·0	...		10·275	10·441	22	32	57·60	51	57 11·4
240	9·5	12·1	...		10·300	12·387	22	32	58·62	52	6 55·2

TABLE III.—*continued.*

Oxford.			Harvard.		Standard Co-ordinates. 1900·0.		Deduced					
							R.A. 1900·0.			N. Dec. 1900·0.		
No.	Meas. Diam.	Mag.	No.	Mag.	ξ'.	η'.	h	m	s	°	′	″
					R.I.	R.I.						
241	11·5	11·7	...		10·316	11·366	22	32	59·03	52	1	48·9
242	36·5	8·4	7803	8·4	10·409	3·584	22	33	1·17	51	22	54·1
243	7	12·6	...		10·393	9·463	22	33	1·32	51	52	17·9
244	12	11·6	...		10·416	13·241	22	33	2·50	52	11	11·3
245	11	11·8	...		10·449	10·543	22	33	3·26	51	57	41·8
246	15	11·1	...		10·489	14·646	22	33	5·05	52	18	12·7
247	5·5	13·0	...		10·515	12·443	22	33	5·63	52	7	11·8
248	10	12·0	...		10·533	11·213	22	33	6·07	52	1	2·7
249	9	12·2	...		10·545	9·483	22	33	6·24	51	52	23·7
250	4·5	13·3	...		10·542	12·995	22	33	6·58	52	9	57·3
251	21	10·2	...		10·560	9·730	22	33	6·76	51	53	37·8
252	12·5	11·5	...		10·579	12·045	22	33	7·67	52	5	12·3
253	7·5	12·5	...		10·587	15·681	22	33	8·39	52	23	23·0
254	6	12·8	...		10·647	12·167	22	33	9·90	52	5	48·8
255	7	12·6	...		10·650	14·224	22	33	10·27	52	16	5·9
256	8·5	12·3	...		10·658	14·360	22	33	10·55	52	16	46·7
257	10	12·0	...		10·680	14·914	22	33	11·34	52	19	32·9
258	5·5	13·0	...		10·709	12·153	22	33	11·91	52	5	44·5
259	6	12·8	...		10·713	12·553	22	33	12·10	52	7	44·5
260	5·5	13·0	...		10·774	13·351	22	33	12·56	52	11	43·9
261	5	13·1	...		10·729	16·085	22	33	13·02	52	25	24·1
262	16	10·9	...		10·791	9·668	22	33	14·24	51	53	19·0
263	9	12·2	...		10·774	13·711	22	33	14·25	52	13	31·9
264	6	12·8	...		10·799	10·039	22	33	14·55	51	55	10·3
265	19·5	10·4	...		10·784	15·707	22	33	14·85	52	23	30·6
266	17·5	10·7	7807	9·3	10·785	15·703	22	33	14·88	52	23	29·4
267	7	12·6	...		10·785	16·205	22	33	14·95	52	26	0·0
268	6	12·8	...		10·820	13·816	22	33	15·76	52	14	3·3
269	4·5	13·3	...		10·836	10·325	22	33	15·79	51	56	36·0
270	6	12·8	...		10·879	10·399	22	33	17·20	51	56	58·1
271	11·5	11·7	...		10·867	13·856	22	33	17·30	52	14	15·2
272	4	13·4	...		10·916	15·815	22	33	19·19	52	24	2·3
273	19·5	10·4	...		10·963	12·086	22	33	20·17	52	5	24·1
274	7	12·6	...		10·959	13·860	22	33	20·31	52	14	16·3
275	12·5	11·5	...		10·984	9·743	22	33	20·50	51	53	41·2

TABLE III.—*continued.*

Oxford. No.	Oxford. Meas. Diam.	Oxford. Mag.	Harvard. No.	Harvard. Mag.	Standard Co-ordinates. 1900·0. ξ'. R.I.	Standard Co-ordinates. 1900·0. η'. R.I.	Deduced R.A. 1900·0. h m s	Deduced N. Dec. 1900·0. ° ′ ″
276	4	13·4	..		10·994	11·978	22 33 21·17	52 4 51·7
277	6·5	12·7	...		11·012	12·273	22 33 21·80	52 6 20·1
278	5·5	13·0	...		11·045	10·274	22 33 22·56	51 56 20·4
279	4	13·4	...		11·033	12·925	22 33 22·58	52 9 35·7
280	3·5	13·6	...		11·058	10·031	22 33 22·95	51 55 7·5
281	22·5	10·0	7816	9·1	11·601	13·017	22 33 41·12	52 10 2·4
282	27	9·4	7818	9·0	12·108	14·415	22 33 57·95	52 17 0·8
283	33·5	8·7	7819	8·9	12·509	21·927	22 34 12·93	52 54 33·2
284	34	8·6	7821	8·9	12·687	9·287	22 34 15·58	51 51 21·2
285	16	10·9	7823	9·4	12·711	9·194	22 34 16·33	51 50 53·2
286	27·5	9·4	7826	8·8	12·936	24·418	22 34 27·79	53 6 59·2
287	28·5	9·3	7827	8·9	13·025	19·607	22 34 29·38	52 42 56·1
288	30·5	9·0	7828	8·4	13·228	15·266	22 34 34·81	52 21 13·4
289	38	8·2	7829	9·0	13·590	2·640	22 34 42·81	51 18 8·8
290	37·5	8·3	...		15·194	25·205	22 35 43·34	53 10 47·9
291	20	10·3	...		15·310	16·779	22 35 43·61	52 28 40·5
292	28	9·3	7845	9·4	15·725	13·501	22 35 55·78	52 12 15·6
293	28	9·3	...		16·696	17·535	22 36 29·50	52 32 21·3
294	26	9·5	7852	9·2	16·749	17·347	22 36 31·14	52 31 24·7
295	50	7·1	7857	6·5	17·697	1·905	22 36 53·75	51 14 8·7
296	30	9·1	...		18·195	9·362	22 37 13·94	51 51 22·5
297	20	10·3	...		19·363	11·678	22 37 53·26	52 2 50·4
298	31·5	8·9	7862	8·7	19·401	14·926	22 37 56·66	52 19 4·2
299	32	8·8	7863	8·5	19·576	11·576	22 38 0·12	52 2 18·5
300	41·5	7·9	7865	8·0	+19·873	14·481	22 38 11·78	+52 16 47·8

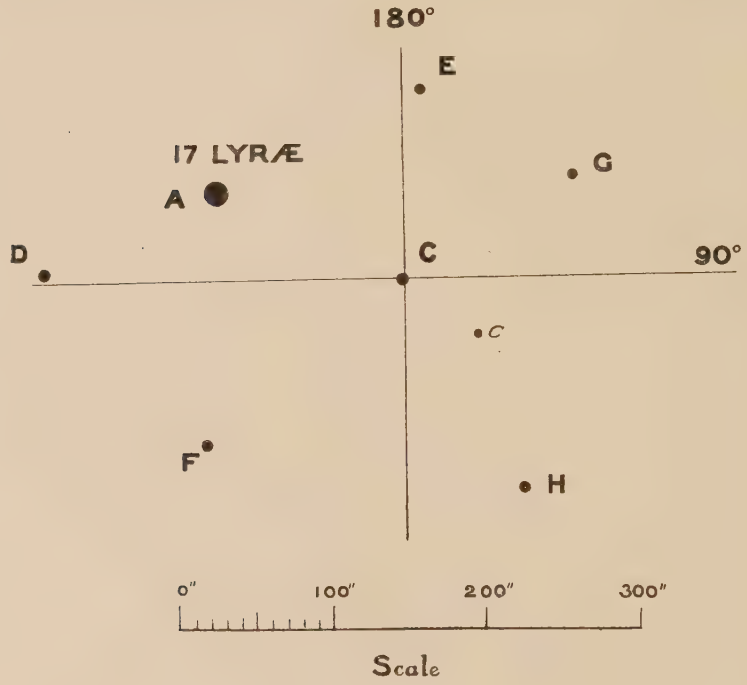
Harvard 7783 is double, and is B.D. +52° 3237.

Harvard 7766 and 7768 is a double.

1911 *January* 13.

The proper motion of the small Star near 17 Lyræ.
By S. W. Burnham.

In *Monthly Notices* for May 1908 I have called attention to a small star near 17 Lyræ, which has a most remarkable proper motion. There is no other example known of a star of the eleventh magnitude having a motion greater than a few tenths of a second of arc, and the number of these is very small, perhaps a score or two. The astrographic plates when duplicated after a suitable interval of



time, will doubtless furnish instances of stars of the tenth to twelfth magnitude where the annual movement is perhaps one or two tenths of a second; but enough has already been done in this direction to show that stars of these magnitudes having any sensible proper motion are excessively rare, and that, for all practical purposes of comparison with the Argelander stars, it is entirely safe to consider them absolutely fixed in space. It is obvious that the detection of any change of place in small stars below the DM limit must depend upon the micrometer and the photographic plate, and that a long time-base is indispensable to distinguish a small movement from the unavoidable errors of observation in any method of comparison. When we come to the really faint stars,

from the thirteenth to the sixteenth magnitude, not a single example is known of such a star, not attached to and moving with a bright star, having any proper motion at all. For many years the writer has been trying to find a faint star with a real and certain proper motion, and many thousands of measures have been made with this object in view, but, so far, without any tangible result so far as movement is concerned.

The proper motion of 17 Lyræ, with which the moving star was first compared, is given from meridian positions as follows:—

Auwers	0″·112 in	68°·5
Newcomb . . .	0·121 ,,	74·8
Boss	0·121 ,,	83·8

Three other small stars in the field with 17 Lyræ have been compared with it. As the measures cover an interval of twenty years, the movement of the large star, deduced from the several measures, should have a more accurate value than that found from the meridian observations. The measures, including my own in 1905 and 1907, give for the proper motion of 17 Lyræ—

	R.A.	Decl.
Measures of AD	+0″·126	+0″·034
,, ,, AE	0·126	0·022
,, ,, AF	0·131	0·040
	0·128	0·032

Therefore the corrected proper motion of the large star is

0″·132 in 75°·8.

The details of these measures will be found in the paper referred to. The mean results of the measures of AC, including two sets of measures made since 1907, are—

A *and* C.

	°	″		
1887·81	72·02	102·28	1n.	Eng.
1894·85	69·23	112·31	2n.	Eng.
1905·72	66·40	127·59	3n.	β
1907·14	66·16	129·90	5n.	β
1908·47	65·50	132·01	5n.	β
1910·33	65·15	134·52	5n.	β

I have shown that these measures, down to and including 1907, after correcting for the motion of A, give for the real proper motion of C—

1″·658 in 48°·2.

For the purpose of obtaining a new and independent value of the proper motion of C, I have connected it with several other stars too faint to have any sensible movement, and these measures were repeated after an interval of two years. The recent measures of these and other stars in the field are as follows:—

A *and* C.

	°	″	
1908·444	65·45	132·12	
460	65·53	131·92	
479	65·69	131·79	
482	65·54	132·17	
518	65·30	132·05	
1910·260	65·08	134·17	
299	65·35	134·76	
337	65·15	134·16	
356	65·20	134·70	
395	64·98	134·82	
1908·47	65·50	132·01	5n.
1910·33	65·15	134·52	5n.

C *and* E.

	°	″
1908·444	173·28	122·60
460	172·93	122·51
479	173·43	122·70
537	173·42	122·61
1910·260	174·18	124·06
299	174·53	124·23
337	174·27	124·40
356	174·48	124·56
375	174·70	124·30

C *and* G (11·3).

	°	″
1908·444	119·80	130·78
460	119·80	130·44
479	120·01	130·67
482	119·89	130·97
518	119·54	130·63
1910·260	120·75	129·55
299	121·25	130·22
337	121·07	129·79
356	121·35	129·82
375	121·40	129·64

C *and* H (12·1).

	°	″
1908·460	29·10	163·07
479	29·10	163·02
482	29·30	163·21
518	29·15	163·00
1910·260	28·58	160·02
299	28·92	159·96
337	28·50	160·27
375	28·83	159·93
395	28·45	160·12

C *and* *e* (13·6).

	°	″
1908·479	52·03	63·23
482	52·07	63·14
518	52·88	63·11
1910·260	52·50	60·10
279	51·55	60·07
337	52·03	60·08
397	52·50	59·44

E *and* G.

	°	″
1910·444	60·32	113·37
460	60·20	113·59
479	60·45	113·64
482	60·47	113·77
518	60·05	113·91
1910·260	60·23	113·37
337	60·30	114·02
375	60·43	113·66
395	59·98	113·91

A *and* E.

	°	″
1908·460	116·47	150·88
479	116·66	150·91
482	116·50	151·19
518	116·20	150·65
1910·299	116·52	150·52
356	116·65	150·44
375	116·33	150·58
395	116·35	151·40

The mean results of the two sets of measures of the small stars around C are—

		°	″	
CE	1908·48	173·26	122·60	4n.
	1910·32	174·43	124·31	5n.
CG	1908·47	119·81	130·70	5n.
	1910·32	121·16	129·80	5n.
CH	1908·48	29·16	163·07	4n.
	1910·33	28·81	160·06	5n.
Cc	1908·49	52·33	63·16	3n.
	1910·32	52·14	59·92	4n.
EG	1908·47	60·30	113·66	5n.
	1910·34	60·24	113·74	4n.
AE	1908·48	116·46	150·91	4n.
	1910·36	116·62	150·74	4n.

As would be expected, there is no change in EG, and none in AE except that due to the motion of A. From the four stars connected with C we have for the proper motion of that star—

		″	″
Measures of	CE	R.A. + 1·255	Decl. + 1·070
,,	CG	1·340	1·318
,,	CH	1·265	1·162
,,	Cc	1·470	1·000
		1·333	1·137

Therefore the annual proper motion is

$$1''\cdot752 \text{ in } 49°\cdot5.$$

The agreement with the former result from the measures of AC is all that could be expected when it is considered that the time interval is less than two years.

In my former paper on this subject I gave the distances of the several stars from a photographic plate taken with the 40-inch in 1907·444. The measuring instrument at that time did not permit the direct measure of position-angles, and they were therefore omitted. Since that time this instrument has been improved in this respect, and I am able to give the relations complete for comparison with those found with the micrometer:—

		°	″
AC	1907·44	65·83	130·58
AD	·44	295·54	126·40
AE	·44	116·50	150·92
AF	·44	356·90	167·78
CE	·44	172·52	121·72

The exposure was not long enough to show the faint stars subsequently connected with C.

Yerkes Observatory:
1910 *December* 10.

Measures of a faint proper-motion Star. By S. W. Burnham.

M. Puiseux, of the Paris Observatory, has called attention to a 10·4m star apparently having a large proper motion (*Bull. Ast.*, xxvi. 416). This was noted on a photographic plate made November 25, 1908. Comparing this with a previous plate, he found for the proper motion of the small star—

0″·708 in 241°·7.

He gives the place (1900)—

R.A. $2^h\ 45^m\ 54^s$
Decl. $+22°\ 37'\ 8''$

I have been favoured with a print from the latest negative, without which identification of so small a star would be difficult, if not impossible, except by the expenditure of much time, since there are no catalogue stars which can be reached with the micrometer.

The print shows three stars, the two nearest exceedingly faint, and very much fainter than the smallest stars usually visible on the astrographic plates. My measures of these stars are—

A *and* B (11·1 . . . 13·2).

	°	″
1910·589	175·68	96·73
·605	176·26	96·93
·666	176·23	95·84
·678	176·37	97·38

A *and* C (13·3).

	°	″
1910·589	113·82	101·07
·605	113·41	101·78
·666	113·03	101·78
·678	113·73	101·12

A *and* D (12·1).

	°	″
1910·091	301·00	162·09
·570	301·03	162·09
·586	301·05	161·85
·589	301·00	161·85

M. Puiseux has kindly furnished me the photographic relative positions of these stars :—

		°	″	
AB	1908·90	176·60	96·37	Photo.
	1910·63	176·13	96·72	4n. β
AC	1908·90	114·20	100·34	Photo.
	1910·63	113·50	101·44	4n. β
AD	1908·90	301·10	161·69	Photo.
	1910·46	301·03	161·97	4n. β

From these positions we have for the apparent motion of A—

AB	R.A. −0″·468	Decl. +0″·185
AC	−0·873	−0·393
AD	+0·218	+0·013

When the errors probable in the photographic and the micrometrical results are considered, it is obvious that no high degree of accuracy for the proper motion, if any exists, could be expected from positions having a time interval of only a little more than one and a half years. The most distant star is discordant when compared with the other two, and must therefore be rejected if use is made of the others. From the mean of AB and AC we have for the proper motion of A—

0″·678 in 261°·2.

The smaller apparent change in AD may be due to errors of observation in all the measures, or to a possible proper motion in that star, although this is to the last degree improbable. To settle this question, now or hereafter, I have connected this star with others shown on the print :—

D *and* E (10·0).

	°	″
1910·701	289·75	101·10
·703	289·78	101·25
·739	289·97	100·58
·742	290·01	100·51

E *and* F (12·5).

	°	″
1910·760	219·60	157·93
·780	219·51	158·21
·818	219·30	158·09

E *and* G (12·5).

	°	″
1910·818	250·58	215·76
·838	250·48	215·65

Professor Frederick Slocum has kindly measured the print referred to, with all possible accuracy, for the positions of these stars. The comparisons are as follows:—

		°	″	
DE	1908·90	290·73	101·29	Photo.
	1910·72	289·88	100·86	4n. β
EF	1908·90	219·71	158·27	Photo.
	1910·78	219·47	158·08	3n. β
EG	1908·90	250·55	215·52	Photo.
	1910·83	250·53	215·70	2n. β

From these measures it would seem probable that D has some proper motion, since there is no evidence of change in EF or EG. The two positions of DE imply a movement in D of 0″·87 in 355°·6.

It would appear that, for all practical purposes, measures from a print can be safely used in lieu of those from the original plate. The print-measures of the other two stars are—

		°	″
AB	1908·90	176·2	96·63
AC	1908·90	114·0	100·27

A careful re-measurement of these stars with the micrometer a few years hence will give a substantially correct value of the movement of both stars, if the apparent change is real.

Yerkes Observatory:
1910 *December* 12.

Micrometrical Measures of Double Stars. By the Rev. T. E. R. Phillips, M.A.

The instrument employed in making the following measures is a 12¼-inch reflector by Calver, furnished with a filar position-micrometer by Cooke.

The positions of Sir John Herschel's stars have been brought up to 1910, and the magnitudes were re-estimated in 1910 December.

The positions of the other stars are for 1900, and the magnitude values are unaltered.

h's Stars.

No.	1910. R.A. h m	Dec. ° ′	P. °	D. ″	Mags.	Nights.	Date.
1474	20 1·8	29 55	351·0	14·34	9·0 10·2	3	1910·604
1520	25·8	25 52	327·9	19·86	9·0 10·2	2	1910·624
1547	33·2	29 31	11·8	15·19	8·8 9·6	3	1909·769
1557	35·6	26 56	208·7	13·44	9·5 9·8	3	1909·769
1561	38·6	28 19	274·8	9·26	9·1 9·7	3	1909·769
1589	20 49·8	27 42	324·1	11·15	10·5 10·8	3	1909·769
1611	21 3·1	27 53	295·9	10·56	9·7 10·4	3	1909·773
1632	14·2	28 3	45·1	8·73	10·2 10·2	4	1909·783
1636	17·5	27 31	184·0	8·07	9·6 10·6	3	1909·772
1661	32·0	25 58	85·9	11·95	8·7 8·7	3	1909·779
1670	34·3	29 34	261·7	11·17	10·2 10·2	3	1909·808
1706	21 52·5	28 34	284·4	9·18	10·0 11·0	3	1909·828
1819	22 47·0	28 46	74·0	17·73	8·5 10·8	3	1909·922

Other Stars.

Names.	1900. R.A. h m	Dec. N. ° ′	P. °	D. ″	Mags.	Nights.	Date.
Σ 379	3 16·8	29 27	101·2	10·45	8·5 8·5	2	1910·866
Σ 401	4 25·3	27 14	270·0	11·25	6·5 7·0	3	1909·866
Σ 427	3 24·5	28 27	208·0	6·77	6·6 7·4	3	1909·884
Σ 2309	18 16·0	25 29	352·8	3·52	8·5 9·0	3	1910·617
Σ 2328	25·5	29 51	73·2	3·47	8·0 8·3	3	1910·626
Σ 2374	39·5	27 37	37·6	14·66	8·8 9·2	3	1910·626
Σ 2430	18 55·4	29 28	1·5	1·82	8·5 8·5	3	1910·630
Σ 2458	19 2·8	27 36	226·3	11·44	8·5 9·0	3	1910·623
Σ 2459	3·2	25 49	232·2	13·92	8·4 9·1	3	1910·623
Σ 2466	4·0	29 38	103·3	2·44	8·0 8·5	3	1910·623
Σ 2524	19 22·5	25 19	98·1	6·44	8·3 8·5	3	1910·613
Σ 2698	20 29·6	27 47	302·9	4·28	8·1 9·0	2	1910·678
Küstner 64	22 18·0	28 19					
AB			160·5	34·10	9·7 10·5	3	1910·644
AC			282·5	33·03	C = 11·2	3	1910·644
CD			114·6	6·26	D = 11·8	3	1910·683

Notes.

h 1589. *h* gives no estimates of position angle, or distance, but describes the pair as "neat." His magnitudes are 10 and 10+ (higher than my estimates); but as the star I have measured appears to be exactly in *h*'s place, the identification is probably correct.

h 1636. *h*'s magnitudes are 10–11 and 10–11, but there appears to be a whole magnitude difference between the two.

h 1661. The R.A. of this star appears to be slightly in error. The star I have measured for *h*'s star is approximately in R.A. $21^h\ 31^m{\cdot}7$, Dec. $+25^\circ\ 58'$. I have found another double star *s.f.* in the same low-power field, which I have observed as follows:—R.A. $21^h 32^m{\cdot}3$ Dec. $+25^\circ\ 53'$ P = 310°·6 D = 15″·40. Mags. 10·2 and 11·0. Nights 2. Date 1910·975.

Küstner 64, C. D. I found this pair difficult, but the measures on the three nights are fairly accordant.

Ashtead, Surrey.

Micrometrical Measures of Double Stars (Eighth Series) and New Double Stars. By the Rev. T. E. Espin, M.A.

Name.	R.A. 1880 h	m	Decl. °	′	P. °	D. ″	Mags.		Nights.	Date. 1910	
B.D. +52°38	0	11·4	+53	3	65·9	14·27	7·2	9·8	2	·873	
Espin 42		16·3	53	56	189·3	10·43	8·5	9·5	3	·976	
Espin 116		24·6	54	59	254·2	7·20	9·0	9·1	3	·974	
Espin 117		27·6	55	3	57·5	2·99	9·3	11·6	4	·979	
h 2008	0	54·5	53	1	68·2	7·30	11·2	11·4	2	·839	
B.D. +54°226	1	1·0	54	12	330·2	8·41	9·2	12·5	3	·772	AB
					97·0	19·52	C=	12·5	2	·788	AC
Espin 156		2·5	53	59	217·0	5·62	8·5	11·4	3	·975	
Espin 119		10·1	53	19	114·8	4·92	8·4	10·0	2	·966	AB
					273·8	40·72		11·2	2	·966	AC
B.D. +52°333		17·2	52	34	339·8	28·97	8·6	8·9	2	·380	
Espin 46		31·0	54	37	33·9	3·00	9·2	10·5	2	·974	AB
					284·9	53·92	C=	9·2	2	·974	AC
Espin 6	1	53·2	52	56	202·1	5·30	8·4	10·5	2	·977	
B.D. +54°534	2	14·9	54	59	268·7	8·92	9·5	9·6	2	·872	
Espin 50	2	36·3	54	25	29·2	2·60	9·5	10·1	4	·983	
Σ 440	3	37·9	50	47	222·5	2·50	9·0	9·2	3	·982	AB
					158·3	50·85	C=	9·0	3	·982	

Name.	R.A. 1880. h m	Decl. ° ′	P. °	D. ″	Mags.		Nights.	Date. 1910	
Küstner 16	3 47·3	50 47	266·0	2·85	9·0	9·3	4	·041	AB
			102·4	15·96	C=	13·5	3	·040	AC (New)
A.G.	5 29·8	53 48	37·3	10·07	9·0	9·1	2	·981	
B.D. +51°1250	6 44·0	51 47	229·4	59·30	8·0	8·4	2	·071	
OΣ 158 rej.	44·0	51 40	304·5	17·03	6·6	10·5	2	·071	AB
			62·5	56·19	C=	10·7	2	·071	AC
h 2428	6 59·3	49 36	68·1	10·60	8·0	9·7	3	·235	
B.D. +50°1399	7 1·8	50 6	126·8	46·03	7·6	9·0	2	·032	
Hu 713	7 55·3	49 38	308·2	4·90	9·1	9·2	2	·241	
B.D. +52°1308	8 17·9	52 34	287·7	16·26	8·9	9·1	2	·169	
Σ 1250	31·4	52 13	167·4	21·76	8·8	8·9	2	·118	
B.D. +50°1607	8 57·2	50 46	257·7	79·32	7·7	8·1	3	·202	
h 2488	9 8·7	48 1	223·9	10·25	11·4	11·6	2	·226	
Espin 720	49·8	50 53	92·9	2·55	9·5	12·0	2	·141	
OΣ 210	9 55·0	46 56	265·4	1·15	8·4	8·5	3	·254	
B.D. +48°1900	10 49·2	+48 0	158·7	48·47	8·2	8·6	2	·215	
B.D. +48°2023	12 22·2	48 33	256·6	28·59	8·9	9·0	2	·316	
Espin 732	13 10·0	49 16	79·3	3·25	9·2	9·4	1	·361	
Espin 608	13 33·0	48 46	269·6	3·02	9·0	9·3	2	·316	
Espin 609	14 33·2	48 14	15·9	4·17	9·0	10·6	5	·423	AB
			116·9	78·60	C=	9·0	5	·423	AC
Σ 1874	38·0	49 38	288·1	26·70	8·1	9·1	3	·482	
Σ 1890	45·6	49 13	45·4	3·57	5·8	5·9	4	·452	
B.D. +48°2251	14 53·3	48 36	124·0	9·70	9·0	12·0	3	·435	
Σ 1920	15 6·8	47 18	290·0	18·43	8·8	8·8	3	·450	
Hu 649	15 20·2	49 57	52·9	4·38	8·4	11·1	3	·448	
Espin 76	16 41·0	50 50	45·4	2·53	9·3	9·5	3	·447	AB
			204·5	43·96	C=	9·7	3	·447	AC
Σ 2100 rej.	40·6	50 53	295·1	23·67	7·9	9·3	3	·480	
B.D. +50°2328	42·0	50 40	289·2	10·72	9·5	11·0	3	·501	
B.D. +51°2156	16 53·6	51 38	282·7	45·45	8·6	8·8	2	·514	
Espin 77	17 5·3	51 0	271·9	17·48	6·7	10·9	4	·571	
Σ 2138	7·7	54 39	136·5	22·22	8·8	9·1	3	·569	
Espin 78	17 54·6	51 12	135·4	6·37	8·6	11·0	3	·535	
B.D. +51°2487	18 0·0	52 0	286·4	8·20	9·4	9·6	2	·655	
Espin 79	0·4	55 52	79·4	6·45	9·3	11·7	3	·611	AB
			93·4	24·70	C=	9·5	3	·611	AC
Espin 187	18 20·9	51 36	201·5	2·38	8·4	8·5	5	·647	AB
			119·4	85·12	C=	9·0	3	·632	AC

Name.	R.A. 1880. h	m	Decl. °	′	P. °	D. ″	Mags.		Nights.	Date. 1910
B.D. +50°2752	19	12·6	50	35	173·3	9·17	8·8	14·0	4	·725
Espin 129		30·4	52	33	223·8	3·47	8·9	10·1	3	·646
A.G.		35·4	51	55	183·8	9·00	9·0	9·1	2	·809
B.D. +53°2311	19	48·7	53	21	320·9	9·82	9·1	9·2	4	·702
Σ 2658	20	10·5	52	45	115·7	5·75			4	·628 AB
					210·2	45·25			2	·601 AC
					83·4	11·25	b=	14·0	3	·602 Bb (New)
					313·7	34·25	a=	12·7	3	·670 Aa
B.D. +52°2775	20	37·3	52	41	26·1	9·12	9·0	9·6	2	·769
B.D. +53°2540	21	0·1	53	29	98·0	55·12	8·0	8·3	2	·618
B.D. +52°2869		2·5	52	38	262·3	9·22	8·8	9·3	2	·590
Espin 209		8·7	52	47	237·0	6·06	9·0	11·5	3	·668
B.D. +54°2512		14·8	54	35	338·0	8·97	8·5	12·5	2	·732
B.D. +51°3051	21	18·5	51	47	40·0	28·62	8·2	8·4	2	·866
B.D. +53°2853	22	16·5	53	51	82·0	20·92	8·9	9·0	3	·784
A.G. 283	22	27·6	54	35	337·8	2·95	8·4	8·6	3	·749
B.D. +53°3154	23	19·3	53	51	251·8	11·35	9·0	9·2	2	·731
Washburn 58	23	30·9	53	17	0·8	3·58	8·8	9·5	3	·853

New Double Stars.

No.	B.D.		R.A. 1900. h	m	Decl. °	′	P. °	D. ″	Mags.		Nights.	Date. 1910
928	+52°	10	0	4·1	+52	51	18·5	7·75	9·4	9·6	2	·852
929	+53°	11		4·7	53	36	116·7	3·42	9·4	10·1	3	·827
930	+54°	6		5·3	55	7	340·8	3·77	9·5	9·5	3	·734
931				18·9	52	9	321·4	2·50	9·6	9·7	3	·867
932	+54°	53		19·5	55	10	91·0	3·37	12·0	12·3	2	·740 BC
							320·0	42·85	A=	9·1	2	·740 AB
933	+54°	89		25·6	54	21	266·3	7·95	8·8	12·3	3	·866
934	+50°	90		26·4	50	58	183·4	5·91	9·0	12·0	3	·898
935	+52°	110		29·6	52	43	288·1	5·80	9·5	12·4	3	·845
936	+55°	136		34·3	55	15	266·0	7·92	9·3	9·3	2	·877
937	+53°	152		44·3	54	1	174·7	5·92	9·3	10·0	2	·788
938	+53°	171		48·0	54	2	214·1	3·81	9·4	10·0	2	·712
939	+54°	179		49·2	54	57	341·3	7·25	9·2	11·1	2	·718
940	+51°	193		51·5	51	42	32·9	7·00	9·0	13·2	3	·880 BC
							356·3	62·60	A=	7·0	3	·880 AB
941	+52°	233	0	53·3	53	9	62·6	3·70	9·5	11·7	2	·839
942	+54°	221	1	0·7	54	40	96·7	4·75	10·5	12·2	3	·772 BC
							174·3	18·97	A=	8·9	2	·741 AB

New Double Stars—continued.

No.	B.D.	R.A. 1900. h m	Decl. ° ′	P. °	D. ″	Mags.		Nights.	Date. 1910
943	+54° 248	1 8·5	54 17	40·3	3·22	11·0	11·3	2	·836 CD
				263·4	58·47	A=	9·1	2	·836 AC
				261·2	33·35	B=	11·2	2	·836 AB
				86·4	24·42			2	·836 CB
944	+54° 256	11·4	54 34	320·4	6·48	8·7	12·0	3	·812
945	+51° 381	37·0	51 52	110·5	4·77	9·0	11·0	2	·857
946	+54° 372	39·5	54 50	189·7	5·60	8·5	13·2	3	·880
947	+54° 376	42·0	54 58	205·1	4·35	9·0	10·3	3	·880 AB
				25·9	26·72	C=	10·7	2	·884 AC
948	+54° 414	48·7	54 20	85·2	3·05	9·5	11·5	3	·840
949	+55° 453	1 51·9	55 19	262·5	5·60	9·3	9·4	2	·890 AB
				18·7	24·05	C=	10·3	2	·890 AC
950	+54° 518	2 12·7	54 21	96·0	5·10	9·2	9·9	2	·788 AB
				287·0	15·90	C=	12·0	1	·832 AC
951	+50° 709	3 3·2	50 32	121·5	2·39	9·5	10·4	4	·934
952	+51° 706	9·4	51 48	115·5	7·21	9·2	11·4	4	·939
953	+50° 794	31·5	50 35	235·0	4·03	9·1	12·2	3	·925
954	+50° 871	3 52·4	50 37	354·4	4·22	9·2	10·4	3	·986
955	+53° 758	4 13·1	53 38	41·3	2·62	9·5	10·7	2	·880
956	+53° 762	15·6	53 44	288·5	2·32	9·3	9·5	2	·880 AB
				182·7	26·35	C=	10·5	1	·887 AC
957	+53° 822	44·7	54 2	350·8	1·60	9·3	9·4	3	·925
958	+53° 823	4 46·3	53 10	4·6	2·87	9·4	9·5	2	·943
959	+51° 1058	5 13·5	51 7	163·8	5·13	9·2	11·7	3	·960
960	+48° 2158	13 48·9	48 14	267·5	4·43	9·5	10·7	3	·394
961	+48° 2215	14 27·5	48 34	319·6	6·95	9·4	9·7	2	·405
962	+48° 2231	40·3	48 9	169·7	8·47	8·9	11·5	2	·430
963	+50° 2129	14 56·2	50 8	242·7	7·63	9·5	12·0	3	·398
964	+53° 1797	15 35·7	52 54	216·9	5·65	9·5	9·7	2	·404
965	+52° 1828	52·8	53 20	331·7	5·00	9·5	9·7	2	·450
966	+53° 1833	15 57·2	53 3	65·1	8·10	9·0	12·0	2	·456
967	+55° 1818	16 8·0	54 55	210·3	8·25	8·5	11·6	3	·496
968	+52° 1986	36·8	52 48	236·5	5·30	9·3	10·5	3	·451
969	+50° 2329	43·4	50 23	235·7	2·60	9·3	9·5	3	·501
970	+52° 1996	44·9	52 29	297·0	3·65	9·1	11·3	3	·510
971	+51° 2143	49·3	51 13	228·9	2·06	10·5	11·7	4	·421 BC
				44·1	41·81	A=	9·4	4	·421 AB
972	+51° 2152	16 53·1	51 50	103·2	2·06	9·8	10·0	3	·510

New Double Stars—continued.

No.	B.D.	R.A. 1900. h m	Decl. ° ′	P. °	D. ″	Mags.		Nights.	Date. 1910	
973	+50° 2436	17 34·2	50 17	267·8	5·87	9·5	13·2	2	·553	
974	+50° 2469	17 46·8	50 13	348·6	3·52	9·1	9·3	3	·505	
975	+56° 2110	18 30·0	56 34	77·8	9·00	8·8	14·0	4	·646	
976	+54° 2054	18 52·0	54 9	277·8	5·38	9·3	9·5	3	·621	
977	+50° 2714	19 0·2	50 45	216·1	5·75	9·0	12·3	3	·565	
978		2·8	51 52	202·4	5·68	9·9	10·0	4	·672	
979	+50° 2731	5·2	50 47	196 0	6·86	8·8	11·1	3	·589	AB
				44·2	19·67	C=	9·7	3	·589	AC
980	+50° 2745	11·2	50 30	190·7	5·90	9·4	13·0	2	·669	
981	+55° 2169	11·9	55 13	90·3	3·17	9·0	11·2	2	·612	
982	+52° 2399	18·9	52 39	85·8	2·98	9·3	10·0	3	·569	
983	+52° 2407	19·9	52 34	211·0	3·35	9·6	10·2	3	·544	AB
				46·8	22·60	C=	10·0	3	·544	AC
984	+53° 2232	20·4	+53 24	314·8	5·83	12·2	12·7	5	·692	BC
				92·2	31·23	A=	8·7	5	·692	AB
985	+53° 2325	19 53·6	54 3	285·2	2·80	9·5	12·0	3	·684	
986	+51° 2784	20 7·3	52 3	287·3	3·30	9·4	9·5	2	·773	
987	+53° 2372	12·0	53 31	291·2	8·17	9·2	9·8	3	·652	
988	+51° 2550	18·9	51 55	13·7	3·95	8·1	11·8	3	·839	
989	+52° 2689	19·6	52 17	269·8	4·33	9·5	11·0	3	·794	
990	+50° 3135	31·9	50 48	299·4	2·42	9·5	9·5	2	·866	
991	+54° 2382	33·1	54 14	296·8	16·27	8·6	9·6	2	·619	AB
				126·7	2·46	9·5	11·9	4	·622	CD
				104·0	63·62			2	·606	AC
992	+51° 2920	36·8	52 6	169·8	7·37	9·1	10·5	2	·857	
993	+54° 2392	36·8	54 27	109·9	2·02	9·5	9·5	3	·712	
994	+54° 2404	39·4	54 14	12·3	5·82	9·5	11·6	3	·671	
995	+51° 2929	39·9	51 45	101·2	9·15	8·1	10·0	3	·862	
996	+52° 2796	43·1	52 57	262·9	8·42	8·0	14·0	3	·854	
997	+53° 2490	44·6	53 45	271·2	2·82	9·5	11·8	3	·735	
998	+50° 3205	45·2	50 32	167·4	3·55	9·4	9·7	3	·900	
999	+50° 3235	54·3	50 41	261·9	3·38	9·3	10·2	3	·945	
1000	+50° 3254	20 59·6	50 18	53·3	4·40	9·5	12·0	2	·944	
1001	+54° 2465	21 0·2	54 55	34·8	4·95	9·0	9·5	3	·688	
1002	+52° 2863	1·0	53 7	65·4	6·80	9·1	12·7	2	·613	
1003	+51° 3000	5·5	51 24	150·0	6·62	9·0	11·2	2	·881	
1004	+50° 3309	15·6	50 14	219·0	7·10	9·0	11·5	1	·909	
1005	+50° 3311	21 15·8	50 24	107·4	2·15	10·0	11·5	2	·944	BC
				141·4	11·30	A=	9·5	1	·909	AB

New Double Stars—continued.

No.	B.D.	R.A. 1900. h m	Decl. ° ′	P. °	D. ″	Mags.		Nights.	Date. 1910	
1006	+51° 3057	21 20·9	53 24	49·0	9·45	8·0	12·0	2	·881	
1007	+53° 2625	24·0	54 7	45·6	2·03	9·5	9·5	4	·646	
1008	+53° 2677	36·2	54 10	310·1	8·30	8·6	11·6	4	·706	
1009	+52° 3018	39·1	52 42	298·1	4·37	9·5	9·5	4	·940	
1010	+54° 2608	40·1	54 59	106·5	2·50	9·5	10·3	3	·784	
1011	+52° 3026	41·7	52 26	218·6	7·45	9·0	11·3	2	·866	
1012	+54° 2622	43·4	54 56	4·2	4·28	9·1	9·2	3	·735	
1013	+53° 2706	44·3	53 52	3·4	3·57	9·3	11·7	2	·855	
1014	+52° 3046	46·6	53 12	226·0	3·82	9·2	12·7	3	·900	
1015	+52° 3072	21 54·8	52 15	243·5	5·65	9·3	9·3	4	·682	
1016	+52° 3122	22 5·1	52 28	295·3	4·04	9·0	11·6	3	·877	
1017	+54° 2721	11·5	54 59	280·0	4·90	10·5	13·0	3	·719	BC
				14·8	15·65	A=	9·0	3	·719	AB
1018	+52° 3172	14·2	52 39	44·3	4·91	9·2	14·0	2	·724	
1019	+52° 3174	14·6	53 11	399·9	7·25	8·8	9·9	3	·867	
1020	+52° 3180	15·6	52 39	245·7	1·90	9·1	9·3	3	·766	
1021	+53° 2867	19·8	54 1	101·3	5·28	8·8	9·3	3	·899	
1022	+53° 2901	26·1	53 34	127·0	6·85	9·3	10·2	2	·888	
1023	+53° 2903	26·7	53 58	268·9	4·12	9·1	9·1	2	·898	
1024	+54° 2795	28·0	54 56	259·3	4·32	8·9	11·0	3	·749	
1025	+54° 2824	34·2	55 3	320·0	5·67	10·2	12·5	2	·751	BC
				330·0	43·60	A=	9·0	3	·771	AB
1026	+52° 3262	36·0	53 2	26·5	2·05	9·0	11·3	5	·969	
1027	+54° 2839	38·0	54 15	216·0	5·45	9·0	12·0	2	·773	
1028	+53° 2961	38·3	53 43	242·8	5·67	7·5	10·0	2	·852	
1029	+54° 2844	39·6	54 20	91·1	5·97	9·3	14·0	3	·808	
1030	+52° 3297	43·7	52 17	1·7	6·55	9·0	11·0	2	·992	
1031	+54° 2870	46·6	55 3	251·7	2·12	9·4	9·5	2	·740	
1032	+52° 3312	47·6	52 39	190·6	2·27	12·0	12·2	3	·877	BC
				134·3	24·55	A=	8·3	3	·877	AB
1033	+53° 3035	52·5	54 13	236·7	2·26	9·5	10·2	4	·737	AB
				279·6	21·37	C=	12·2	2	·732	AC
1034	+54° 2893	55·8	55 6	329·2	6·17	9·4	11·4	3	·690	
1035	+52° 3355	57·4	52 45	149·9	5·62	9·4	12·2	2	·907	
1036	+52° 3359	22 58·8	52 56	86·5	2·65	9·5	10·6	2	·907	
1037	+54° 2923	23 6·1	54 21	341·0	3·30	9·5	9·9	2	·672	
1038	+52° 3382	6·6	52 25	24·0	7·68	9·1	12·5	3	·901	AB
				191·8	9·22	C=	13·5	3	·901	AC

New Double Stars—continued.

No.	B.D.	R.A. 1900.	Decl.	P.	D.	Mags.		Nights.	Date. 1910	
		h m	° ′	°	″					
1039	+52° 3403	23 10·5	52 48	208·9	1·19	9·0	9·4	4	·880	
1040	+54° 2943	12·6	54 56	235·8	2·55	9·4	9·6	4	·723	
1041	+53° 3118	12·7	53 53	133·6	2·40	9·5	9·7	3	·726	
1042	+51° 3581	14·1	52 12	306·2	4·10	9·1	9·3	2	·992	
1043	+54° 2974	22·0	+54 25	118·9	2·00	10·6	11·0	6	·709	BC
				29·1	29·45	A=	8·5	3	·684	AB
				20·0	43·24	D=	10·0	4	·692	AD
1044	+52 3449	22·5	52 30	259·8	3·92	9·5	11·5	2	·992	
1045	+54° 2980	22·9	55 2	259·2	2·77	9·5	11·3	2	·743	
1046	+53° 3195	30·5	53 20	344·9	7·53	9·4	13·9	3	·853	
1047	+54° 3028	37·7	54 17	269·9	3·85	9·4	10·0	3	·780	
1048	+54° 3029	38·3	54 22	325·6	5·10	9·6	9·7	3	·780	DE
				247·4	14·30	B=	11·5	2	·788	AB
				282·3	16·35	C=	11·0	2	·788	AC
				15·4	69·95			2	·754	AD
1049	+52° 3550	47·8	52 26	217·3	4·87	9·3	10·6	2	·898	
1050	+54° 3061	48·7	54 20	228·8	4·68	9·1	12·0	3	·729	AB
				310·5	39·17	C=	9·3	3	·729	AC
1051	+52° 3566	23 52·4	53 9	46·4	5·92	9·4	10·7	2	·833	AB
				180·7	8·85	C=	11·7	2	·833	AC

Notes.

1015.—A 14 Mag. 15″ ± N.

1017.—An 11 Mag. P = 138°·1 D = 11″·7, and a 13 Mag. P = 177°·2 D = 15″·9.

1027.—A *comes* 15″ ± *s.f.*

Observations of Halley's Comet at Windsor, N.S. Wales.
By John Tebbutt.

I forward herewith the places of Halley's comet resulting from observations made by me with a square bar micrometer on the 8-inch equatorial. The differential measures have been corrected for errors in the form and orientation of the micrometer, and for the comet's proper motion, but the refraction corrections, being hardly sensible, have been disregarded. The resulting places of the comet are, of course, uncorrected for parallax.

The comet's nucleus was faint in December, and was subject to small fluctuations of brightness. In the morning sky on April 22, civil time, the tail could be traced for two or three degrees from the head, and, owing to the Moon's presence for several mornings, the comet was not a conspicuous object. The Moon having considerably waned, and the sky being beautifully clear, I measured the tail with a sextant on May $1^d\ 17^h\ 24^m$ and found it to be $7^\circ\ 36'$ in length. The measures were made by reflecting the head of the comet to the estimated place of the end of the tail. The length on May $7^d\ 17^h$, during the absence of the Moon, was $14^\circ\ 10'$. The following measures were subsequently made, namely, May $9^d\ 17^h\ 15^m$, $18^\circ\ 7'$; May $15^d\ 17^h\ 15^m$, $50^\circ\ 29'$; May $16^d\ 17^h\ 30^m$, $57^\circ\ 0'$. On the last occasion the twilight slightly interfered, and the tail was observed to deviate slightly to the north of what was regarded as a prolongation of the radius vector. The morning of the 18th, civil time, was cloudy. The following morning, however, turned out beautifully clear and the Moon had set. The tail at this time was a magnificent object, stretching from the horizon under Venus to a point near θ Aquilæ, which was on its northern edge. It seemed to be lost in the Milky Way. It was about two degrees wide at the horizon, and tapered off to a width of about one degree. The head being near the Sun, and, of course, below the horizon, could not be seen. The tail could certainly be traced as far as a point whose R.A. $= 20^h\ 10^m$, and Declin. $= 3^\circ$ south.

The Sun's disc was closely watched, by projection on a large sheet of white paper, from May $18^d\ 22^h\ 15^m$ to $19^d\ 3^h\ 37^m$, but nothing could be detected beyond the usual solar spots. The atmosphere was remarkably clear till $2^h\ 14^m$, when small detached clouds came up from the south. About the middle of the interval just stated the image of the Sun on the paper appeared to be not quite so bright as it was during the earlier and later part of the examination.

The comet could not again be seen till May $21^d\ 6^h\ 30^m$, when the length of the tail by sextant was $17^\circ\ 18'$. On the evening of the 28th the tail was directed to a point two or three degrees south of Jupiter, and its length was measured as $44^\circ\ 13'$. On $29^d\ 7^h\ 15^m$ it was seen to better advantage in consequence of the Moon's

absence, and its length was 41° 49′. On the following evening the estimate was 30°, and on June 5 it was 16¼°. Cloudy weather then intervened, and on June 12 and 13, 2° or 3° only of the tail was visible, owing to the presence of the young Moon. Cloudy weather again prevailed till the 24th, when the comet had pretty well ceased to be visible without optical aid.

During the May observations the comet's nucleus was subject to great variations of brilliancy. An extraordinary increase in brightness was particularly noted on May 30, and the contrast between its appearance then and on the preceding and following evenings was very remarkable.

Observations of Halley's Comet.

Windsor Mean Time, 1909 and 1910.					No. of Comps.	Comet – Star		Comet's apparent				Reduction to App.		Comp. Star.
						Δ R.A.	Δ N.P.D.	R.A.			N.P.D.	R.A.	N.P.D.	
	d	h	m	s		m s	′ ″	h	m	s	° ′ ″	s	″	
Dec.	3	10	51	1	7	−3 40·43	+ 2 26·3	4	19	41·22	74 16 36·1	+3·40	−11·0	1
,,	4	10	38	59	5	−4 51·41	+ 6 25·4	4	15	37·29	74 22 13·4	+3·40	−11·1	2
,,	4	10	38	59	5	−7 48·07	+ 8 4·6	4	15	37·59	74 22 14·5	+3·41	−10·9	1
,,	5	10	39	2	8	−3 14·93	− 6 56·7	4	11	25·26	74 28 21·3	+3·40	−11·5	3
,,	6	10	42	0	7	−7 31·09	− 0 45·4	4	7	9·10	74 34 32·6	+3·40	−11·5	3
Jan.	1	9	0	12	4	−2 22·87	+ 1 9·5	2	18	20·26	78 26 47·4	−0·39	+ 0·6	4
,,	2	9	10	42	4	−5 55·86	+10 30·6	2	14	47·25	78 36 8·6	−0·41	+ 0·7	4
May	25	7	41	6	5	−3 45·22	+ 5 58·1	8	37	56·88	81 17 30·5	−0·26	− 1·5	5
,,	26	6	11	22	4	−2 31·72	− 4 1·7	8	55	55·88	82 45 42·5	−0·18	− 0·7	6
,,	29	6	30	57	7	+2 29·48	− 7 33·9	9	32	20·81	85 54 17·5	−0·04	+ 0·7	7
,,	30	6	43	27	10	+1 2·34	− 2 17·2	9	40	39	86 38	+0·01	+ 1·1	8
,,	31	6	26	52	10	−0 16·63	+ 5 11·3	9	47	17·43	87 12 48·0	+0·04	+ 1·3	9
June	4	6	57	50	7	+2 37·76	+ 1 18·3	10	5	52·62	88 53 0·8	+0·06	+ 1·9	10
,,	5	6	33	4	7	+0 14·72	+ 3 39·0	10	9	7·61	89 10 37·9	−0·08	+ 2·0	11
,,	7	8	50	58	5	−0 0·97	− 2 52·6	10	15	1·45	89 42 37·4	+0·10	+ 2·3	12
,,	8	7	22	7	5	+0 32·38	+ 8 57·2	10	17	18·45	89 55 1·2	+0·11	+ 2·4	13
,,	12	6	47	38	8	+3 12·28	+ 6 41·0	10	25	13·61	90 38 33·6	+0·11	+ 2·5	14
,,	12	6	47	38	8	+1 25·30	− 1 28·5	10	25	13·75	90 38 24·5	+0·12	+ 2·6	15
,,	13	6	55	50	7	+3 5·12	+ 7 47·8	10	26	53·56	90 47 40·7	+0·11	+ 2·5	15
,,	25	6	52	33	4	−4 17·14	− 1 48·9	10	41	37·79	92 11 10·9	+0·12	+ 2·8	16
,,	25	6	52	33	4	−5 29·09	+ 4 2·3	10	41	37·91	92 11 12·5	+0·12	+ 2·8	17
,,	27	6	47	42	6	−2 21·28	+ 9 22·1	10	43	33·63	92 22 21·7	+0·10	+ 2·6	16
,,	30	7	13	45	6	−0 11·92	+ 1 53·5	10	46	19·08	92 38 51·8	+0·06	+ 2·4	18
July	1	7	4	14	10	+0 40·52	+ 7 13·4	10	47	11·51	92 44 11·6	+0·05	+ 2·3	18

Mean Places of the Comparison Stars for the beginning of the Year of Observation.

Star.	R.A. h m s	N.P.D. ° ′ ″	Authorities.
1	4 23 22·25	74 14 20·8	Gr. 9-yr. Cat., 1872, No. 420; Gr. 10-yr. Cat., 1880, No. 713 Gr. 2nd 10-yr. Cat., 1890, No. 1376; Gr. 2nd 9-yr. Cat 1900, No. 280.
2	4 20 25·30	74 15 59·1	Yarnall, 1860, 3rd ed., No. 1946; Gr. 2nd 10-yr. Cat., 189 No. 1365.
3	4 14 36·79	74 35 29·5	γ Tauri, American Ephemeris.
4	2 20 43·52	78 25 37·3	Wash. Gen. Cat., 1875, No. 513; Edinburgh Cat., 1900, No. 31
5	8 41 42·36	81 11 33·9	Lalande, No. 17272; Schjellerup, No. 3220.
6	8 58 27·78	82 49 44·9	Lalande, No. 17866; Glasgow Cat., 1870, No. 2327.
7	9 29 51·37	86 1 50·7	Lalande, No. 18822.
8	9 39 37	86 40	Equatorial, 8½ mag.
9	9 47 34·02	87 7 35·4	Schjellerup, No. 3628–9; Glasgow Cat., 1870, No. 2567; Rad cliffe Cat., 1900, No. 847.
10	10 3 14·80	88 51 40·6	Lamont, No. 2811.
11	10 8 52·81	89 6 56·9	Lamont, No. 2859.
12	10 15 2·32	89 45 27·7	Lalande, No. 20038–9; Radcliffe Cat., 1900, No. 875.
13	10 16 45·96	89 46 1·6	Glasgow Cat. 1870, No. 2688; Radcliffe Cat., 1900, No. 877.
14	10 22 1·22	90 31 50·1	Glasgow Cat., 1870, No. 2718; Glasgow Cat., 1890, No. 886.
15	10 23 48·33	90 39 50·4	Lamont, No. 2952.
16	10 45 54·81	92 12 57·0	Lamont, No. 3103.
17	10 47 6·88	92 7 7·4	Lamont, No. 3109.
18	10 46 30·94	92 36 55·9	Glasgow Cat., 1890, No. 917; Radcliffe Cat., 1890, No. 2813.

The Observatory, Windsor, N.S. Wales:
1910 *November* 29.

Observations of Occultations of Stars by the Moon, made at the Royal Observatory, Greenwich, in the Year 1910.

(*Communicated by the Astronomer Royal.*)

Day. 1910.	Phenomenon.		Mag.	Telescope.	G.M.T. h m s	Observer.
Jan. 17	Disapp.	*f* Piscium	5·3	Astrographic	6 46 10·28	W. S.
17	,,	,,	,,	Sheepshanks	10·33	B. E.
19	,,	B.D. +14°513	8·0	Astrographic	8 30 26·71	W. S.
19 (*c*)	,,	B.D. +14°515	8·9	,,	8 44 54·53	W. S.
19 (*d*)	,,	Lalande 5791	8·3	,,	9 22 33·84	W. S.
19	,,	B.D. +15°438	8·2	,,	10 5 32·29	W. S.
19	,,	B.D. +14°524	8·6	,,	10 14 28·42	W. S.
21	,,	B.D. +23°828	8·3	,,	9 47 14·47	W. S.
22	,,	W.B. (2) V 1597	8·3	,,	5 30 23·03	W. S.
22	,,	W.B. (2) V 1596	7·5	,,	5 31 54·58	W. S.
22	,,	W.B. (2) V 1612	7·8	,,	5 43 23·59	W. S.
22	,,	B.D. +24°1045	7·9	,,	5 56 25·56	W. S.
22 (*c*)	,,	B.D. +24°1052	8·8	,,	6 44 25·89	W. S.
22	,,	W.B. (2) V 1694	8·7	,,	6 54 4·30	W. S.
22 (*e*)	,,	B.D. +25°1097	8·9	,,	8 34 49·31	W. S.
22	,,	W.B. (2) V 1816	8·5	,,	8 43 6·45	W. S.
22	,,	W.B. (2) V 1833	8·5	,,	9 5 41·45	W. S.
Feb. 15	,,	B.D. +13°457	9·5	,,	6 45 50·24	W. S.
15	,,	B.D. +13°455	9·1	,,	6 48 17·34	W. S.
15 (*c*)	,,	B.D. +13°464	8·9	,,	8 1 21·95	W. S.
15 (*c*)	,,	B.D. +13°467	8·9	,,	8 41 14·44	W. S.
15	,,	B.D. +13°466	7·4	,,	8 41 28·51	W. S.
15	,,	B.D. +14°484	8·4	,,	9 6 20·53	W. S.
15	,,	B.D. +14°490	8·9	,,	9 41 38·30	W. S.
15	,,	B.D. +14°492	8·1	,,	9 42 35·25	W. S.
15	,,	B.D. +14°495	8·8	,,	10 7 7·45	W. S.
17	,,	B.D. +22°763	9·0	,,	10 25 28·44	W. S.
17 (*c*)	,,	B.D. +22°764	9·4	,,	10 29 8·34	W. S.
18	,,	B.D. +25°959	9·2	,,	7 48 9·11	J. P.
18	,,	W.B. (2) V 1207	7·7	Merz	7 52 9·77	A. L.
18	,,	,,	,,	Astrographic	10·16	J. P.
18	,,	,,	,,	Thompson	9·97	Wh.
18	,,	B.D. +24°963	7·4	Merz	9 4 30·94	A. L.
18	,,	,,	,,	Thompson	31·14	Wh.
18	,,	W.B. (2) V 1417·8	9·0	Astrographic	11 10 55·44	J. P.

Day. 1910.	Phenomenon.	Mag.	Telescope.	G.M.T. h m s	Observer.
Feb. 18 (*e*)	Disapp. W.B. (2) V 1473	8·1	Astrographic	11 39 37·13	J. P.
Mar. 16	,, B.D. +21°662	9·2	,,	9 16 47·47	J. P.
16	,, B.D. +22°711	9·4	Great Eq.	9 50 4·10	Wh.
16	,, B.D. +21°668	8·3	Corbett	10 26 19·37	Wh.
18 (*f*)	,, W.B. (2) VI 619	8·4	Great Eq.	7 16 32·35	Wh.
18	,, B.D. +25°1314	8·0	Astrographic	8 26 34·56	W. S.
18	,, ,,	,,	Sheepshanks	34·19	A. L.
19	,, W.B. (2) VII 615	8·5	Great Eq.	7 25 3·25	Wh.
Apr. 15	,, B.D. +25°1649	8·5	Astrographic	11 7 30·62	J. P.
15	,, ,,	,,	Sheepshanks	31·18	Wh.
15 (*g*)	,, B.D. +25°1652	9·0	,,	11 9 15·89	Wh.
15	,, A Geminorum	5·1	,,	12 5 4·21	Wh.
June 16	,, Piazzi XIII 67	6·8	,,	10 50 29·82	R. C.
18	,, 8 Libræ	5·4	,,	10 38 52·09	H. A.
18	,, ,,	,,	Astrographic	51·49	J. P.
18	,, α Libræ	2·9	Old Altazimuth	10 49 40·46	A. C.
18	,, ,,	,,	Sheepshanks	41·11	H. A.
18	,, ,,	,,	Astrographic	40·31	J. P.
19	,, Lalande 28445	6·8	Sheepshanks	11 10 21·53	H. A.
20	,, ρ Ophiuchi	4·7	,,	9 18 25·86	R. C.
July 25	,, Lalande 45965 *	6·3	Great Eq.	11 49 58·90	Wh.
Aug. 19	,, 35 Capricorni	6·0	Astrographic	13 2 40·51	J. P.
Oct. 15	,, B.D. −11°6032	6·3	Old Altazimuth	8 54 57·02	H. A.
Nov. 14	,, Mayer 51	7·0	Astrographic	5 17 41·39	J. P.
16 (*b*)	,, Piazzi III 60 *	6·4	Great Eq.	10 39 50·42	S. E.
16 (*b*)	,, ,,	,,	Merz	(54·29)	C. D.
16 (*b*)	,, ,,	,,	Detached Tel.	(55·29)	H. F.
16 (*b*)	,, ,,	,,	Sheepshanks	51·81	W.
16	,, B.D. +18°487 *	8·3	Great Eq.	11 10 49·16	S. E.
16	,, ,,	,,	Merz	(46·19)	C. D.
16	,, B.D. +17°558 †	9·4	,,	11 45 33·54	C. D.
16 (*c*)	,, Anon. A. †	10·5	Astrographic	11 45 47·82	W. S.
16	,, B.D. +18°489 †	8·6	Great Eq.	11 46 52·35	S. E.
16	,, ,,	,,	Merz	52·22	D. E.
16	,, ,,	,,	Corbett	51·75	W. B.
16	,, ,,	,,	Sheepshanks	52·13	W.
16	,, ,,	,,	Detached Tel.	53·43	P. M.
16	,, ,,	,,	Astrographic	51·54	W. S.
16	,, Renz 101 †	10·4	Great Eq.	11 52 13·87	S. E.
16	,, ,,	,,	Merz	12·34	C. D.

Day. 1910.	Phenomenon.		Mag.	Telescope.	G.M.T. h	m	s	Observer.
Nov. 16	Reapp.	B.D. + 18°487 †	8·3	Great Eq.	12	2	25·80	S. E.
16	,,	,,	,,	Merz			26·13	C. D.
16	,,	,,	,,	Thompson			26·63	D. E.
16	,,	,,	,,	Detached Tel.			25·92	H. F.
16	,,	,,	,,	Sheepshanks			(29·89)	W.
16	,,	,,	,,	Astrographic			(32·58)	W. S.
16	Disapp.	Renz 110 †	10·9	Great Eq.	11	7	43·23	S. E.
16	,,	,,	,,	Merz			42·77	C. D.
16	,,	,,	,,	Thompson			42·77	D. E.
16	,,	Renz 111 †	9·7	Great Eq.	12	11	60·43	S. E.
16	,,	,,	,,	Thompson			62·05	D. E.
16 (*c*)	,,	,,	,,	Astrographic			59·52	W. S.
16	Reapp.	Anon. A. †	10·5	Great Eq.	12	18	21·80	S. E.
16	,,	Renz 94 †	10·5	,,	12	23	47·71	S. E.
16	Disapp.	B.D. + 18°492 †	8·3	Merz	12	24	59·69	C. D.
16	,,	,,	,,	Thompson			59·49	D. E.
16	,,	,,	,,	Detached Tel.			58·85	H. F.
16	,,	,,	,,	Sheepshanks			59·41	W.
16	,,	,,	,,	Astrographic			59·08	W. S.
16 (*b*) (*c*)	,,	Anon. B. †	10·3	,,	12	32	10·23	W. S.
16	,,	B.D. + 18°491 †	9·5	Merz	12	36	4·39	C. D.
16	,,	,,	,,	Great Eq.			3·03	W. B.
16	,,	,,	,,	Astrographic			4·60	W. S.
16	Reapp.	B.D. + 18°489 †	8·6	Corbett	12	48	12·23	S. E.
16	,,	,,	,,	Merz			12·37	C. D.
16	,,	,,	,,	Thompson			13·17	D. E.
16	,,	,,	,,	Great Eq.			12·03	W. B.
16 (*a*)	,,	,,	,,	Sheepshanks			12·96	W.
16	,,	,,	,,	Astrographic			12·30	W. S.
16	,,	Anon. C. †	10·5	Great Eq.	12	52	14·07	W. B.
16	Disapp.	B.D. + 18°494 †	8·3	Merz	13	1	3·15	C. D.
16	,,	,,	,,	Thompson			3·55	D. E.
16	,,	,,	,,	Great Eq.			2·93	W. B.
16	,,	,,	,,	Detached Tel.			2·93	H. F.
16	,,	,,	,,	Sheepshanks			2·67	W.
16	,,	,,	,,	Astrographic			2·50	W. S.
16	,,	B.D. + 18°496 †	9·5	,,	13	1	13·97	W. S.
16	Reapp.	Anon. D. †	10·5	Great Eq.	13	9	30·45	W. B.
16	,,	B.D. + 18°492 †	8·3	Merz	13	16	50·52	C. D.
16	,,	,,	,,	Great Eq.			50·35	W. B.

Day. 1910.	Phenomenon.		Mag.	Telescope.	G.M.T. h m s	Observer.
Nov. 16	Reapp.	B.D. + 18°492 †	8·3	Detached Tel.	50·38	H. F.
16 (*a*)	,,	,,	,,	Sheepshanks	50·61	W.
16	,,	,,	,,	Astrographic	50·42	W. S.
16	,,	B.D. + 18°494 †	8·3	Corbett	13 24 23·50	S. E.
16	,,	,,	,,	Merz	23·05	C. D.
16	,,	,,	,,	Thompson	23·85	D. E.
16	,,	,,	,,	Great Eq.	23·20	W. B.
16 (*b*)	,,	,,	,,	Detached Tel.	(22·60)	H. F.
16	,,	,,	,,	Sheepshanks	23·07	W.
Dec. 5 (*c*)	Disapp.	ω Sagittarii	4·8	Astrographic	5 15 37·33	H. A.

(*a*) Instantaneous.
(*b*) Observation doubtful.
(*c*) Faint, ill-defined.
(*d*) Wind violent, could not hear clock.
(*e*) The observer's time has been diminished by 5 mins. Observer noted "minute doubtful."
(*f*) The observer's time has been increased by 2 mins.
(*g*) The observer's time has been increased by 1 min.

The apertures of the telescopes used are as follows:—

		Clock used.
Great Equatorial . .	28 inches.	Dent 2009. Nov. 16, chronometer.
Corbett telescope . .	6½ ,,	,, ,, ,,
Thompson Equatorial .	26 ,,	Arnold 1.
Merz refractor . .	12¾ ,,	,,
Guiding Telescope of Astrographic Equatorial	10 ,,	Dent 2017. From Feb. 15, chronometer. From June 18, Dent 2014.
Sheepshanks Equatorial	6¾ ,,	Earnshaw.
Old Altazimuth . .	4 ,,	Chronometer.
Detached telescope .	4 ,,	,,

The initials S. E., A. C., C. D., D. E., W. B., H. F., W., W. S., P. M., R. C., B. E., A. L., J. P., H. A., Wh., are those of Mr. Eddington, Mr. Crommelin, Mr. Davidson, Mr. Edney, Mr. Bowyer, Mr. Furner, Mr. Witchell, Mr. Stevens, Mr. Melotte, Mr. Cullen, Mr. B. Evans, Mr. Lyne, Mr. Pierce, Mr. Acton, and Mr. Wheate.

The asterisk (*) after a star's name signifies that the phenomenon took place at the Moon's Bright limb.

The dagger (†) after a star's name signifies that the phenomenon took place at the Moon's Eclipsed limb.

Where neither of the above marks is affixed, the phenomenon was at the dark limb.

The appellation "Renz" refers to the list of stars prepared by F. Renz for the total eclipse of 1891 November 15, and printed in

Astr. Nach., No. 3061, and, with revision of the star places, in *Astr. Nach.*, 3274. Dr. R. Wittram of Pulkovo issued a circular last August pointing out that this list was again available for the 1910 eclipse, the position of the Moon being almost the same. He also gave apparent places of all the B.D. stars contained in the Renz list: these places, and the places in *Astr. Nach.*, 3274, have been used in the discussion of the occultations of Nov. 16. There are four stars (Anon. A., B., C., D.) not contained in the Renz list, for which accurate places are not at present available.

The following table gives the assumed places of the stars occulted on November 16, and the resulting equations. The tabular R.A. and N.P.D. of the Moon are assumed to require corrections of x'', y''; those of the Star, e'', f''; the mean of the observed times, omitting those enclosed in brackets, is assumed to require a correction t^s. The tabular parallax and semidiameter are assumed to require multiplication by the factors $1+\frac{m}{1000}$, $1+\frac{n}{1000}$ respectively. The coefficients of e, f are not printed separately, since they are equal, with signs reversed, to those of x, y respectively; that of n is sensibly $-1''$ throughout.

Disappearances and reappearances are indicated by the sign of the coefficient of t, which is $-$ for the former, $+$ for the latter.

Star.	App. R.A. 50°+	App. N.P.D. 71°+	Resulting Equation.					
	′ ″	′ ″	″	″	″	″	″	″
P.III. 60	29 32·4	33 12·2	$-6\cdot95=-\cdot42x$	$+\cdot89y$	$-\cdot41t$	$+1\cdot53m$	$-1n$	
+18°487	42 31·3	25 25·8	$-7\cdot67=-\cdot35$	$+\cdot93$	$-\cdot37$	$+1\cdot74$	-1	
+17°558	46 1·7	49 32·1	$+5\cdot63=+\cdot31$	$-\cdot94$	$+\cdot35$	$-1\cdot89$	-1	
+18°489	70 32·3	33 55·1	$-5\cdot25=-\cdot94$	$\cdot\cdot04$	$-\cdot43$	$-0\cdot05$	-1	
Renz 101	72 20·4	27 19·9	$-6\cdot80=-\cdot91$	$+\cdot28$	$-\cdot48$	$+0\cdot63$	-1	
+18°487	42 31·3	25 25·8	$+4\cdot82=+\cdot91$	$+\cdot27$	$+\cdot37$	$+0\cdot33$	-1	
Renz 110	78 2·7	20 34·9	$6\cdot66=-\cdot83$	$+\cdot48$	$-\cdot49$	$+1\cdot15$	-1	
Renz 111	78 14·1	17 4·8	$-7\cdot46=-\cdot73$	$+\cdot63$	$-\cdot47$	$+1\cdot46$	-1	
Renz 94	63 20·7	41 12·2	$+5\cdot07=+\cdot34$	$-\cdot93$	$+\cdot35$	$-2\cdot03$	-1	
+18°492	87 27·6	30 4·3	$-3\cdot69=-\cdot90$	$-\cdot29$	$-\cdot36$	$-0\cdot20$	-1	
+18°491	86 57·6	9 47·5	$1\cdot08=-\cdot61$	$+\cdot77$	$\cdot\cdot44$	$+1\cdot85$	-1	
+18°489	70 32·3	33 55·1	$+7\cdot87=+\cdot56$	$-\cdot80$	$+\cdot43$	$-2\cdot01$	-1	
+18°494	99 37·8	30 5·0	$-3\cdot90=-\cdot65$	$-\cdot72$	$-\cdot17$	$-0\cdot96$	-1	
+18°496	103 5·6	25 52·4	$-4\cdot34=-\cdot83$	$-\cdot48$	$-\cdot30$	$-0\cdot32$	-1	
+18°492	87 27·6	30 4·3	$+6\cdot35=+\cdot38$	$-\cdot91$	$+\cdot36$	$-2\cdot24$	-1	
+18°494	99 37·8	30 5·0	$+1\cdot70=-\cdot07$	$-1\cdot00$	$+\cdot16$	$-1\cdot98$	-1	

No attempt is made to derive e, f, t from these equations. Also, since the signs of the coefficients of y, m are the same throughout, we cannot separate y, m in the solution. As the error of the tabular parallax is probably not greater than $0''\cdot5$, m does not

exceed $\frac{1}{8}$. n is also known to be small, since Struve's semidiameter was used in forming the equations. x, y are much the largest quantities: to determine them, the equations were divided into two groups, those where the coefficients of x, y are alike in sign, and those where they are unlike. Taking the sum of each group, the solution is $x = +6''{\cdot}82$, $y = -{\cdot}3''{\cdot}22$. These values are consistent, since the error is likely to be mainly along the Moon's orbit, in which case y would be $-\frac{1}{3}x$.

Assuming these values of x, y, we add the equations for Disappearances and those for Reappearances to obtain values of n.

The Disappearances give $n = -{\cdot}27$, and the Reappearances $n = -{\cdot}89$. The Mean is $-{\cdot}58$, which would indicate that the assumed semidiameter is too great by $0''{\cdot}58$.

Royal Observatory, Greenwich:
1911 *January* 13.

A suggested method of determining the Stellar Brightness of a faint Comet. By H. Knox Shaw, B.A.

This note originated with the large discrepancy between the magnitudes of Halley's comet on 1910 November 11, as estimated by Professor Barnard, who observed it visually, and by myself from a photographic plate. Professor Barnard gave * its magnitude as 11, while I estimated its magnitude as about 14·5, by comparing the plate which was taken with an exposure of 40 minutes at a mean altitude of 17° with one taken on 1909 October 15, with an exposure of 32 minutes, at a mean altitude of 62°. The image of the comet appeared slightly weaker on the recent plate; and putting this down to the difference of altitude, the comet was estimated to be of about the same magnitude as it was in the middle of October 1909, which magnitude has been given by several observers as 14·5.

The large discrepancy between the magnitudes as observed at Yerkes and Helwân called for further investigation of the Helwân plates, and the method described in this note suggested itself. The procedure is to count over an area of the plate $40' \times 30'$ (one-third of a square degree) the number of stars which are apparently as bright as the comet, *i.e.* those stars the density of whose images is equal to or greater than that of the comet. This number is multiplied by three to reduce it to number per square degree, its logarithm is taken, and with this logarithm and the galactic latitude as arguments the table given in No. 18 of the *Publications of the Astronomical Laboratory at Groningen* is entered, and the limiting magnitude of the stars counted deduced. This is not the magnitude

* *A.N.*, 4457.

of the comet, as it requires a correction due to the trail of the stars on the plate. This correction is determined as follows:—

Let M = the magnitude of the comet.
m = the magnitude of a star whose image has the same density as that of the comet.
l = the measured length of an image of such a star.
b = the measured breadth of the image.
T = the length of the exposure in minutes.

Then the equivalent length of exposure on the stars is $\frac{b\mathrm{T}}{l}$. And since we are dealing with photographic and not visual magnitudes, in order to obtain one magnitude fainter on the plate we must increase the length of exposure in the ratio $10^{0.5}$ (see Professor Turner, *M.N.*, lxv. p. 763).

And thus we have

$$\mathrm{M} = a + 2{\cdot}0 \log \mathrm{T},$$

and

$$m = a + 2{\cdot}0 \log \frac{b\mathrm{T}}{l},$$

where a is a constant,

whence

$$\mathrm{M} = m + 2{\cdot}0 \log \frac{l}{b},$$

which is the formula giving the correction to be applied for trail of the star images.

This method has been applied to all the material available, and the results are given in Table I., the first five columns of which explain themselves; in the sixth column, under b, is given the galactic latitude of the plate centre, under N the number of stars per square degree, counted as described above, and under m their limiting magnitude, as determined from Kapteyn's table. The next column gives the measured length and breadth of the star images, and the next the correction for trail. The last column gives the deduced magnitude of the comet, found by applying this correction to the mean of the two magnitudes given under m. The stars were counted twice on each plate, with an interval of several days between each counting. The values of N differ in some instances rather considerably, but the effect on m is never serious.

The following plates call for special remark:—

Plate 3. The telescope was made to follow the stars, and the comet is slightly trailed.

Plate 4. The images of the stars and the comet are equally elongated. The same applies to plates 8, 9, and 10.

Plates 7, 8, and 9 are instances of plates for which the method is not suitable. The comet has become too bright, or rather the limiting magnitude, m, of the stars counted is too bright for a count to give a reliable indication of their magnitude. A small accidental excess of richness of distribution has then a large effect on the resulting magnitude. Plate 7 is

a good example of this. The star trails are long, the image of the comet is very bright, and only eight stars, equally bright, were counted. A much shorter exposure would have been sufficient to show the comet, and would have afforded a more reliable determination of its magnitude.

Plate 10. The image of the comet is extremely faint, and the method resolved itself into counting all the stars visible on the plate.

Plate 11. The guiding was bad, and the star trails are rather irregular.

The magnitudes given in Table I. are in very fair agreement with those determined, both visually and photographically, elsewhere, except in the cases of plates 7, 8, and 9, commented upon above, and Professor Barnard's observation. It is interesting to note that M. Javelle observed the comet visually at Nice * on November 8, 10, 11, and 12, and estimated the magnitude of its nucleus to be between 14 and 15. Perhaps Professor Barnard's observation refers to the total light of the comet.

It is now necessary to consider what are the chief errors to which this method is liable. They seem to be these:—

(i) The error of estimating what stars have images of equal density with that of the comet. This must be common to all methods in which the density and not the size of the comet's image is measured. And any method depending on the measurement of the diameter of the comet's image is open to grave objection for two reasons. Firstly, because the comet's true image is not a point; and unless what is to be measured is the total light received from the comet, this will make the measurement of the diameter of the comet's image quite incomparable with those of the stars of the same magnitude. And if the point aimed at is to measure the total light received from the comet, the presence of a nucleus or any central condensation will be a serious complication. The nucleus will appear on the photographic plate, but the proportion of the surrounding haze which appears on the plate will depend on the length of the exposure. And secondly, because the image of the comet on the plate is usually faint, and of the faint images formed by a reflector the density is much more sensitive to a small change of magnitude than is the diameter. To return to the difficulty of deciding whether the image of a particular star is fainter than that of the comet or not, it will be found that in a rich field many stars are counted on one occasion and rejected on another. In sparse fields, however, where the counting or rejection of a particular star is more important, more time can be spent on comparing each doubtful star image with that of the comet. The use of a *réseau* will be found to greatly facilitate the counting.

* *C.R.*, tome 151, p. 850.

(ii) Error due to a wrong correction for trail of the star images. Photographs of comets are sometimes necessarily taken at low altitudes, and the star trails are not always perfectly uniform. The correction for trail is then likely to be uncertain. It is important that the trails should be no longer than is necessary. Several of the plates quoted above were given quite unnecessarily long exposures. It is also important that the stars measured for trail should be those the density of whose images is sensibly the same as that of the comet. The brighter images have a greater breadth in proportion to their length. This is probably the most unsatisfactory part of the method.

(iii) Error due to irregularities in the distribution of the stars. At first sight the possibility of the comet being in a region differing much in star density from the mean for that galactic latitude seemed a serious objection to the method. Professor Kapteyn found* that the probable error of a single determination of magnitude found by counting the stars down to a mean magnitude of 13·5 over 45 regions was ±0·42. He, however, pointed out that this value was affected by accidental errors both of limiting magnitude and counting, and by systematic differences between the visually-determined magnitudes of the several authorities employed, as well as by real irregularities in the star distribution. The limiting magnitude of each plate depended sometimes on one and usually on only two stars, whose magnitudes had been determined visually; and the counting was rather uncertain, as it had often to be made on paper prints instead of on the original negative. One would therefore be led to expect a smaller probable error due to this cause in the method here described, as it is free from any direct reference to visual magnitudes, and the counting is done under better conditions.

As an indication of how great departures in star density from the mean one should be prepared to expect, I selected 26 plates taken with the Reynolds reflector with various exposures, and counted all the stars visible on them over areas varying from one-twelfth to one-third of a square degree. The fields mostly contain nebulæ, but the actual regions covered by large nebulæ were purposely avoided. The results are contained in Table II. The meaning of the first eight columns will be readily understood, as they are similar to those in Table I. The last two columns require explanation. It is assumed that the limiting magnitude, m, shown on the plate, is connected with the length of the exposure T by the following equation—

$$m = a + 2{\cdot}0 \log \mathrm{T}.$$

* *Publications of the Astronomical Laboratory at Groningen*, No. 18, p. 39.

The ninth column gives the values of a on this supposition, and the last column gives the residuals from the mean value of a, which is 11·8. A value +0·2 in the last column means that that plate showed stars down to 0·2 of a magnitude fainter than that given by the equation

$$m = 11{\cdot}8 + 2{\cdot}0 \log T.$$

There seems to be no relation between the sign of the residuals and either the length of exposure or the galactic latitude, and the variations of the residuals seem at least as great between different plates taken of the same field as between different fields. The different plates are likely to differ in the number of stars shown, owing to difference in the quality of the nights and in the speed of the plates, especially the latter. The plates used were Imperial Flashlight and Ilford Monarch, both very fast plates, but the latter vary much in speed with their age. Plates 8 and 17 were quite fresh Monarchs, while plates 1, 3, and 25 were very stale. The residuals do not seem any larger in the Milky Way than elsewhere. Field 1 does not lie in one of the clouds of the Milky Way, and might be expected to show a large negative residual.

Table II. is thus reassuring. The residuals seem to be largely due to the plate and night, and not to the field. It is impossible to judge what residuals would be obtained were it possible to photograph different fields with similar plates and on similar nights, but it does not seem that we should be too optimistic if we put the probable error of the determination of a magnitude due to the irregularity of the star distribution at ±0·2.

(iv) There may be a systematic error underlying Kapteyn's table. Of this I have no means of judging. Professor Turner has, however, expressed the opinion * that his magnitudes are too bright.

In conclusion, it is claimed for this method that it is capable of determining the photographic magnitude of a faint comet from a good plate to within half a magnitude. The error of the determination might possibly exceed this if the comet lay in one of the dark patches of the Milky Way, but a special allowance for this would be justified. It would be interesting to compare the method with others, but I am, unfortunately, ignorant of how such magnitudes are determined at other observatories. In the absence of any recognised method, there seems to be room for one, even if it can only claim to be approximate.

* *M.N.*, lxix. p. 70.

TABLE I.

Plate.	Comet.	Date.	Exp.	R.A.	Dec.	*b*.	N.	*m*.	Star Images.	Corr.	M.
			m	h m	°	°			" "		
1	Halley	1909 Aug. 24	100	6 13	+17	+ 2	2340	14·4			
							2610	14·5	24×6	+1·2	15·7
2	,,	Sept. 13	150	6 19	+17	+ 3	2622	14·5			
							2472	14·5	10×5	+0·6	15·1
3	,,	Sept. 15	150	6 19	+17	+ 3	5124	15·2			
							4968	15·2	9×7 (comet)	−0·2	15·0
4	,,	Sept. 16	163	6 19	+17	+ 3	5190	15·2			
							4992	15·2		0·0	15·2
5	,,	Oct. 15	32	6 11	+17	+ 1	780	13·4			
							801	13·4	15×5	+1·0	14·4
6	,,	Oct. 22	52	6 5	+17	0	345	12·6			
							321	12·5	33×6	+1·5	14·1
7	,,	Dec. 7	30	4 2	+15	−26	24	10·9			
							24	10·9	75×7	+2·1	13·0
8	,,	1910 Jan. 13	2	1 41	+10	−49	51	12·3			
							54	12·3		0·0	12·3
9	,,	Jan. 16	2	1 34	+ 9	−50	69	12·6			
							72	12·7		0·0	12·7
10	,,	Nov. 7	7	12 3	−14	+47	228	14·0			
							225	14·0		0·0	14·0
11	,,	Nov. 11	40	12 4	−15	+46	174	13·6			
							189	13·7	21×8	+0·8	14·5
12	,,	Nov. 12	55	12 4	−15	+46	147	13·4			
							141	13·4	15×6	+0·8	14·2
13	,,	Nov. 29	60	12 5	−16	+45	246	14·0			
							231	14·0	12×6	+0·6	14·6
14	,,	Dec. 27	80	11 56	−18	+44	216	13·8			
							208	13·8	24×6	+1·2	15·0
15	,,	Dec. 28	60	11 56	−18	+44	225	13·9			
							237	14·0	21×6	+1·1	15·0
16	1910*a*	1910 Apr. 11	20	22 39	+21	−33	192	13·3			
							189	13·3	11×8	+0·3	13·6
17	d'Arrest	1910 Oct 21	8	20 22	−30	−34	168	13·2			
							156	13·1	8×4	+0·6	13·7

TABLE II.

Plate.	Field.	R.A. h m	Dec.	*b.*	N.	*m.*	Exp. m	*a.*	Resid.
1	1	18 16	−16°	−1°	4140	15·0	90	11·1	−0·7
2					7824	15·6	100	11·6	−0·2
3	2	17 15	−38	−2	5202	15·2	55	11·7	−0·1
4					6984	15·5	60	11·9	+0·1
5	3	17 53	−28	−2	396	12·7	3	11·7	−0·1
6					1908	14·2	10	12·2	+0·4
7	4	6 19	+17	+3	13000	16·2	150	11·8	0·0
8	5	7 37	−15	+5	6372	15·5	40	12·3	+0·5
9					6300	15·5	90	11·6	−0·2
10	6	0 17	+26	−36	408	14·3	20	11·7	−0·1
11	7	20 59	−12	−36	102	12·7	4	11·5	−0·3
12	8	5 2	−38	−36	276	13·9	9	12·0	+0·2
13					291	13·9	15	11·5	−0·3
14	9	22 24	−22	−58	858	16·5	210	11·9	+0·1
15					954	16·6	240	11·8	0·0
16					408	15·2	60	11·6	−0·2
17	10	14 24	+30	+67	123	13·7	3	12·7	+0·9
18	11	2 18	−21	−67	345	15·3	100	11·3	−0·5
19					414	15·6	100	11·6	−0·2
20	12	0 10	−39	−77	246	15·0	60	11·4	−0·4
21	13	1 30	−30	−79	435	16·1	120	11·9	+0·1
22					342	15·7	120	11·5	−0·3
23	14	0 42	−22	−89	372	16·0	150	11·6	−0·2
24	15	0 43	−26	−89	549	16·9	120	12·7	+0·9
25					222	15·0	100	11·0	−0·8
26					432	16·3	120	12·1	+0·3

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